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Economy in Shop Operation

With a considerable part of the five per cent rate increase granted, the eastern roads will surely derive some relief from the period of depression. The public has shown that it believes the railways need assistance and has so vigorously expressed this feeling that the Interstate Commerce Commission has granted a large part of the requested increase in rates. Everything possible should be done by the railroads to keep the cost of operation to a minimum consistent with safety and efficiency. The shop men are in an excellent position to assist substantially in this respect. The careful use of material, careful workmanship and economical use of supplies are all factors that will materially contribute towards the necessary economies. Retrenchment in the mechanical department has a direct effect on the employees, and they should be made to realize that by their help money can be saved to the end that the shops will be kept in operation.

Car Construction in 1914

A most interesting feature of the figures for car construction in 1914 is the increase in the number of all-steel box cars built, the greater part of which is due to the adoption of the all-steel type of construction on the Pennsylvania Railroad. There is also a considerable increase over 1913 in the number of steel underframe box cars built, while the number of steel frame box cars falls off materially. On first consideration it might seem that the steel frame construction is losing in popularity, but there may be other explanations for the falling off. In a year of depression like the one just past many of the railroads order little or no equipment, so that the cars built are for a comparatively few roads and it is difficult to point to any definite tendency which is indicated by the construction figures. There is also an increase in the number of steel underframe passenger cars built, but most of these were built for a comparatively few roads, some of which favor this type of construction. The all-steel car preponderates, although there is a falling off in the total number of cars built. Of the wooden passenger equipment cars, the greater proportion were milk, refrigerator, and cars for other special service.—(*From our Weekly Edition.*)

Increased Capacity in Existing Locomotives

The ever pressing need of greater trainloads has increased locomotive dimensions and capacities so rapidly that the large locomotives of a few years ago, which the more modern equipment replaces, have developed a serious problem for the motive power and operating departments to solve. There are numbers of these locomotives which possess more capacity than is needed for way-freight or branch line service, yet in many cases it has been necessary to place them in such service, as well as in switching. Many of these engines are capable of developing a maximum tractive effort which will start very heavy trains, but are deficient in boiler capacity and are therefore incapable of economically hauling such trains for any distance. If there were some way of increasing the steam making capacity of such locomotives they could take their place in heavy main line service; in fact, such an increase in boiler capacity could very easily obviate the necessity of a road's making considerable expenditures for new locomotives of greater capacity. The difficulties attending the use of superheated steam with slide valves and the expense necessary in applying piston valve cylinders have prevented the use of superheaters in many such instances. Of the past year's locomotive development, therefore, perhaps the one of most direct interest to railways is that which has shown the possibilities of increased capacity obtainable from existing locomotives. It is now possible to apply piston valves without going to the extent of entirely new cylinder

and saddle castings, and the use of the superheater and the brick arch, even on narrow firebox locomotives, has given remarkable results in increased hauling capacity. It is therefore probable that the immediate future will see the modernizing of the large locomotives of a few years ago, in considerable numbers.—(*From our Weekly Edition.*)

Riveting in Steel Car Construction

Assembling and riveting are matters of the utmost importance in steel car construction and should be of general interest to all who are in any way connected with the building or repairing of steel cars. The article by H. A. Hatfield, the first part of which is published in this issue, while containing much of general interest, should be particularly interesting to those who are called upon to inspect the various processes in the construction of steel equipment. As pointed out by Mr. Hatfield the strength and rigidity of a steel car depend primarily upon the tightness of the rivets. The securing of tight rivets under the conditions usually existing in the construction of steel freight cars demands eternal vigilance on the part of the inspector, whose troubles would undoubtedly be considerably decreased if the author's suggestions relative to the proper heating of rivets and maintenance of tools were more generally observed. While the article in general does not fit the conditions found in boiler shop practice, it contains several practical suggestions which might be applied there with as good results as in the car shop. It will be published in two parts.

Enginemen and Economy

A western road which is carrying on a progressive campaign in fuel economy is making use of a diagram, in lectures to the enginemen on fuel economy, showing the amount of money spent during the past fiscal year for locomotive fuel, locomotive repairs, freight car repairs, enginemen's wages, enginehouse expenses, water, lubrication and supplies. It shows clearly the relation between each item and gives an idea of the magnitude of the different items. As an example, the cost of the fuel consumed is 175 per cent of the enginemen's wages, the cost of locomotive repairs is 116 per cent, and the cost of freight car repairs is slightly over 100 per cent. The men are shown that aside from their own wages, which are about 18½ per cent of the total amount of the items mentioned, they are more or less responsible for the expenditure of over 17½ million dollars. They are thus made to feel that they have an important part to play in the railroad game from an economic standpoint in addition to the running of the locomotives. By making a saving of only 1 per cent of this total they will save the company very nearly 4½ per cent of their wages. Economy brought home to them in this way makes a strong impression, and they all seem to be interested in the fact that they are responsible in some considerable degree for these large expenditures.

Machine Tool Efficiency

Many railway men have the idea that railway shop work is so entirely different from that performed in industrial plants that no comparison can be made between the two. To a certain extent this is true. In almost every case the railway shop finds it necessary to perform a number of different jobs on the same machine, whereas the large industrial shops have a sufficient amount of regular work so that individual machines can be kept busy on one, or at most, a few, specific jobs. By doing this it is possible for them to experiment sufficiently to find the speed and feed that will give the most economical results. But it is also true that the railway shop can, to some extent, profit by these experiments. It can apply the rate of metal cutting in many cases to its own works; it may obtain information that will show how the increased cost of new and improved machinery will be more than justified by increased production, and, to some extent, new methods of doing work will be suggested. The manufacturers of new machines purchased should always be consulted as to how the best results may be obtained from their machine tools. Occasions have been known where high grade machines have been grossly underrated simply on account of a lack of knowledge as to what the machines will stand. The tool builders are willing to demonstrate their machines thoroughly, as it is to their best interests to have their products produce economical results and the railway shops should take advantage of this opportunity in studying how to secure more effective results in shop production.

Locomotive Development in 1914

The number of locomotives ordered in the calendar year 1914 was 1,265, which constitutes a marked falling off from 1913, when there were 3,467 ordered. The falling off in building was of course due to the general business depression, but the poor business conditions have by no means eliminated developments tending toward the improvement of the locomotive.

A year ago we referred to what is without doubt the highest development of the Atlantic type locomotive, embodied in the latest engine of that type built by the Pennsylvania Railroad. These locomotives were largely the result of long continued experiments along the lines of refinement in design and increase in boiler capacity. A number of them have been built and are in daily service hauling very heavy trains on extremely fast schedules. The same policy which resulted in the production of this Atlantic type locomotive has, during the past year, produced on the Pennsylvania a Mikado and a Pacific type locomotive which are especially noteworthy. Interchangeability of parts has been carried out in these two locomotives to a considerable extent, the boilers of the two engines being identical. On the testing plant at Altoona the Pacific type locomotive recently developed approximately 3,200 horsepower, a truly remarkable figure, and in this connection it is interesting to note that this horsepower was obtained when the locomotive was equipped with a type of exhaust tip having four internal projections, and that the horsepower obtainable with the ordinary form of exhaust tip was considerably less.

Heat treated steel takes a prominent place in the design of the Pennsylvania locomotives, and of locomotive design in general it may be said that alloy steels continue in favor for such parts as axles, crank pins, main and side rods, frames and springs.

The large locomotive is again to the fore in 1914. The Pacific type locomotives built by the American Locomotive Company for the Chesapeake & Ohio lead in point of total weight for this type, this being 312,600 lb., while the maximum tractive effort of 46,600 lb. developed by these engines is also the greatest for this type. The heaviest locomotive of the Mikado type of which we have record is also a Chesapeake & Ohio engine and weighs 322,500 lb. The Baldwin Locomotive Works built during the year for the Baltimore & Ohio, a 2-10-2 type locomotive which has a total weight of 406,000 lb., and is the heaviest locomotive ever built on a single set of drivers. The world's record for large locomotives was again broken by the construction for the Erie Railroad by the Baldwin Locomotive Works of a 2-8-8-8-2 type, Triplex compound articulated locomotive using the weight of the tender for adhesion and having a total weight of 853,000 lb. This locomotive has a theoretical maximum tractive effort of 160,000 lb. and has hauled a train of 251 loaded cars weighing 17,912 tons. A few locomotives of the Mountain, or 4-8-2 type, were built during the year, but they are intended for service under special conditions and there does not seem to be any general tendency to go beyond the Pacific type for hauling heavy passenger trains.

The mechanical stoker has taken a prominent place in increasing locomotive capacity, and there are a number of locomotives now in service which would not have been built had it not been

possible to fire them by mechanical means. On large hand-fired locomotives the use of coal pushers in the tender, for moving the coal forward within the reach of the fireman, has greatly increased.

During the year experiments have been completed resulting in the successful use of powdered coal in locomotive fireboxes, and while the results of these experiments are not yet available it is probable that when published they will prove of very considerable interest and value.

The large locomotive is likely to continue in favor in new construction, although it may be doubted that the two-cylinder type can be carried much beyond present dimensions because of limitations in clearance. The possibilities in the use of three cylinders were brought out recently in a discussion before the American Society of Mechanical Engineers by J. B. Ennis, chief mechanical engineer of the American Locomotive Company, and it would not be surprising to see steps taken in the near future toward developing large locomotives with this cylinder arrangement. With few exceptions the compound locomotive has gained nothing in favor during the past year, although the Mallet type continues in use for the particular classes of work for which it is suited, and it is of special interest to note that a large locomotive of this type which was built by the American Locomotive Company in 1912 for the Virginian Railway has developed in service a horsepower somewhat over 3,000. This power is noteworthy when it is considered that it was necessarily developed at low speed.

For the future it may be said that further economies will probably develop from superheating, and while the use of feed water heaters in America has thus far been only of an experimental nature, the results obtained are promising and would seem to indicate its development before long toward an extensive use. Considered from all standpoints the locomotive development of the immediate future will probably continue along the lines of increased capacity through the means of refinement in design and the application of economy producing features and those which tend directly to increase boiler capacity.—(*From our Weekly Edition.*)

To Committees of Mechanical Associations

At this time of the year, about midway between the annual conventions of the various railway mechanical associations, attention of the members of the committees appointed to prepare reports for the 1915 meetings should be called to the fact that, if they are not already doing so, it is time for them to take an active interest in the work which has been assigned to them. Too often the tendency is to postpone such matters until the last minute, a report then being hurriedly compiled just in time to present to the convention. Usually in such cases it is based on an incomplete investigation. Railway men are very busy, and this is just the reason such matters should be started early. The life and standing of any railway association depends entirely on the quality of the work it does, and the members of committees are under definite obligations to the other members of the association to submit reports that will be of material benefit to them and to the association as a whole.

The higher railway officers watch the progress and work of the associations in order to know whether or not it is worth while to send their men to the conventions. The larger associations are finding it necessary to rely on some of the minor associations for investigations that they have not now time to handle. The responsibility of the minor associations is therefore increasing, and it is the duty of every committee member to assume his share of this responsibility. In too many cases the chairmen of the committees do all the work. This is not fair to them, nor is it fair to the association, for under such circumstances the report gives only one man's point of view. Every committee member should give the best he has and feel the same responsibility as the chairman. Carefully study the subject assigned and get all the information possible from every available source. Get busy now; send your letters of inquiry out so that there will be sufficient time to carefully analyze the replies and get additional information when necessary. Make your 1915 convention the best in the history of the association.

NEW BOOKS

Proceedings of the American Railway Tool Foremen's Association. Compiled and published by Owen D. Kinsey, secretary of the association, Chicago, Ill. 145 pages, 6 in. by 9 in. Bound in paper.

This book is the official report of the sixth annual convention of the American Railway Tool Foremen's Association, which was held in Chicago, July 20 to 22, 1914. Among the most important subjects considered are Tool Room Grinding, Safety as applied to Grinding Wheels, Distribution Systems of Shop Tools, and Special Tools for Drilling, Reaming and Milling, the latter subject including considerable information regarding the work that is being done at the Burnside shops of the Illinois Central. The book is neatly illustrated and contains valuable information.

Proceedings of the International Railroad Master Blacksmiths' Association. Compiled and published by A. L. Woodworth, secretary and treasurer, Lima, Ohio. 296 pages, 6 in. by 9 in. Bound in cloth.

The twenty-second annual convention of the International Railroad Master Blacksmiths' Association was held in Milwaukee, August 18 to 20, 1914. This publication of the proceedings of that convention includes papers on Frame Making and Repairing, the Heat Treatment of Metals, Spring Making, Oxy-Acetylene and Electric Welding, and other subjects of interest to blacksmiths. A number of shop kinks were also included which show economical methods adopted by various members for performing routine railroad blacksmith work. Addresses by H. E. Manchester, J. F. DeVoy, and J. J. Hennessey, of the Chicago, Milwaukee & St. Paul, are also included.

Compressed Air. By Theodore Simons, E. M., C. E., Professor of Mining Engineering, Montana School of Mines. 167 pages, 6 in. by 9 in. Illustrated. Bound in cloth. Published by the McGraw-Hill Book Company, 239 West Thirty-ninth street, New York. Price $1.50.

The author's purpose in the preparation of this treatise was to give the student and general reader such an insight into the principles underlying the production, transmission and use of compressed air as to enable him to comprehend the operation of the various appliances and to judge of their merit. The book is divided into four parts, the first three dealing with the production, transmission and use of compressed air, the fourth containing descriptions of compressors and accessories. The whole subject is treated theoretically, the development of the various formulas which form the basis of compressed air calculations being gone into in considerable detail. Interspersed throughout the text are concrete examples which are worked out in detail. By carefully following these through the student has a means not only of checking his understanding of the principles involved, but is in a measure brought to a realization of the physical conditions represented by the symbols in the formulas. Higher mathematics has been sparingly used, its principal application being in the development of horsepower formulas for air compression and expansion. In Part IV several compressors and compressor appliances are described, this part of the text being well illustrated with photographs. It is not extensive enough, however, to do more than give the reader a general knowledge of the various methods of applying the principles set forth earlier in the book. A number of tables are contained in an appendix for convenience in the practical application of formulas.

While the book is elementary throughout, containing brief statements of all the fundamental laws involved, its greatest field will be found among engineers or engineering students whose previous education has given them a knowledge of these laws. Such readers should be able to obtain a thorough understanding of the problems involved in air compression and its use.

COMMUNICATIONS

MECHANICAL DEPARTMENT SALARIES

COUNCIL BLUFFS, Iowa.

TO THE EDITOR:

There are railway mechanical department officers in the United States having under their charge as many as 4,000 shop men, 500 locomotives, 40,000 cars, as well as monthly pay rolls of $100,000, besides many other responsibilities, and as compensation they receive the munificent salary of $300 a month.

Now to be reasonably competent to hold such a position, a man must start as a lad of 15 or 16 years of age, work hard, read much, and be especially intelligent. Then, if he is fortunate enough, he may be appointed, at, say, 40 years of age to such a position. He must be familiar with all branches of railroad work, must furnish advice on all technical subjects and his work is a constant grind with little or no opportunity for promotion but decided possibilities of "losing out" for reasons beyond his own control.

Such inadequately compensated mechanical officers are among the sources of greatest extravagance of railroads today. The better class of men go to other livelihoods, where not only more money and glory are to be obtained, but greater peace, happiness, and satisfaction as well.

Such niggardly compensation of railway officers is very expensive in the end.

F. J. MILLER.

MELTED BOILER TUBES

CLIFTON FORGE, Va.

TO THE EDITOR:

I have read with a great deal of interest the communications concerning melted boiler tubes in the August and November numbers of the *Railway Age Gazette, Mechanical Edition,* and it calls to my mind a similar experience with which we were confronted some time ago.

The locomotive in question had been in yard service in a district where the boiler feed water contained a great deal of scale-forming matter, and when placed in the roundhouse for repairs it was decided to build a light wood fire in the firebox, with the idea of possibly ridding the firebox sheets of the heavy scale. In a very short time my attention was called to the red hot condition of the barrel of the boiler. The front was removed, and we found that the tubes had melted in two and that the inside of the boiler, particularly the front end, resembled an iron furnace.

Someone has advanced the theory that this tremendously hot fire is accounted for by using wood which contained a great deal of rosin, which, when the fire was built, passed up and was deposited in the tubes, and did not ignite until the fire in the firebox attained a high temperature. There being no water in the boiler, and the tubes being thin, it did not take a great deal of heat to burn them in two. It is also said that cases are on record where coal running high in volatile matter, such as Pocahontas, would deposit a soot on the inside of the tubes, which, when the temperature became sufficiently high, would ignite and burn fiercely. This deposit is more noticeable in stacks on stationary plants, where flames 40 or 50 ft. high are often seen issuing from the stack.

I do not attach much importance to the former theory, as the wood used in building the fire in this engine contained very little, if any, rosin, and granting such as being the case I do not believe that it could have been deposited in the tubes, as it would surely have burned, being of a low flash point. The latter explanation does not seem reasonable, as I do not believe that the tubes in this engine contained enough soot to create such an intensely hot fire. It is my opinion that the fire was caused by a great quantity of wood pulp igniting in the boiler, this pulp having been placed there by the engine crew to stop leaks.

If anyone has any suggestion to offer as to what caused the tubes to burn in this engine I would be glad to hear from him.

E. A. MURRAY,
Master Mechanic, Chesapeake & Ohio.

TRUSS RODS ON STEEL MEMBERS

HARVEY, Ill.

TO THE EDITOR:

The editorial on British Steel Coaches in the October number contains a criticism of the use of truss rods on steel underframe sills. No doubt there are good reasons why truss rods are not to be desired on steel members, but the reason given in the editorial does not appeal to the writer. When applied to a sill the truss rod and sill together become a truss, the sill being the compression member and the rod the tension member, both being without tension or compression with no load, and the tension and compression being equal when a load is applied. An initial tension in the rod is not necessary in order that it do its share. Truss rods are frequently used on steel members in other lines of work to good effect. A truss rod would be more effective on a steel sill than on a wooden one for the reason that the compression member of the truss would not shorten, due to drying out or by compressing at the truss rod anchors, as is the case with a wooden sill.

THEO. F. H. ZEALAND.

PAINTING PATTERNS.—The practice of painting patterns to indicate the parts of a casting which are to be machined and those to remain rough has been followed in steel foundries for some time. It is learned that a similar practice is gaining application in gray-iron foundries. The parts of a pattern corresponding to parts requiring no machine work are tinted gray, while the parts which are to be machined are painted yellow, with the parts of the pattern indicating the location of cores in red. Castings are sometimes spoiled because the molder does not know what part is to be finished in the shop.

CHEMICAL PROPERTIES OF RAIN WATER.—It is believed that water as it leaves the clouds is in a practically pure condition, and that the first opportunities for its contamination arise immediately following the beginning of its descent to the surface of the earth. In falling through the atmosphere, either as rain or otherwise, it takes up certain substances. Naturally these substances taken up are dependent upon the substances contained in the atmosphere through which it falls, which in turn are to a large extent due to the industrial conditions existing upon the surface of the earth. But there is one substance always present in the air, and that is carbon dioxide (CO_2) or carbonic acid gas. In a district where bituminous coal is the chief fuel, and where this fuel is largely impregnated with sulphur, which is the case generally with the middle states bituminous coal, the sulphur, in the process of combustion, is also converted into another gas just the same as is the carbon into CO_2 gas. This sulphur gas naturally impregnates the atmosphere and is dissolved by water falling through the air, and eventually converted into sulphuric acid. Sulphuric acid is of such a character that when in even a weak solution in water it will dissolve metallic iron very rapidly. There is also present in the atmosphere, at all times, another class of substances commonly known as the ammonia class. The atmosphere carries some of this in practically all neighborhoods at all times, consequently more or less of this class of substances becomes a part of the impurities contained in natural waters. Assuming now that the water has passed down through the atmosphere and has reached the immediate surface of the earth, it has taken up some carbon dioxide, some ammonia, undoubtedly some sulphur gases, and probably some oxygen.—*W. A. Converse, before the Railway Club of Pittsburgh.*

THE STEAM LOCOMOTIVE OF TODAY

Discussion at Annual Meeting of the American Society of Mechanical Engineers, December 2, 1914

On page 571 of the November, 1914, issue we published the report of the sub-committee of the Railroad Committee of the American Society of Mechanical Engineers which was presented at the annual meeting of the society, held in New York, December 2, 1914. In the following pages are given extracts from the discussion on Boiler Design, Fan Drafting of Locomotives, Front Ends and Draft Appliances, Combustion, What the Stoker Has Done for the Locomotive, Superheaters, Feed Water Heating, Heat Treated and Alloy Steels and Possibilities of the Future.

BOILER DESIGN IN RESPECT TO HEATING SURFACE

F. J. Cole, Consulting Engineer, American Locomotive Company:—In recent years, locomotives have increased so much in dimensions, weight and power that methods employed in the past are no longer adequate in proportioning the grate, heating surface, length and diameter of tubes, etc., or to predetermine how best a locomotive boiler may be designed to suit certain requirements, the type, tractive effort and limitations of weight being known.

The size of cylinders is usually fixed by the permissible axle load allowed upon the track or bridges, in connection with the type, the diameter of the driving wheels, the boiler pressure and the factor of adhesion. After these fundamental features are decided upon, the boiler proportions must be outlined to see whether the required amount of heating surface can be obtained without exceeding the limits of weight.

There are two general questions involved in the consideration of this subject, namely, how many pounds of steam per hour are required to supply the cylinders in order to develop the maximum horsepower; and what proportion of grate, firebox and tube heating surface will best produce this amount of steam.

The locomotive, unlike most steam plants, varies in the speed and power developed. It must be able to run at any intermediate speed between starting and its full velocity and at the same time develop all degrees of tractive effort within its capacity. At slow speeds the maximum pull must be exerted in order to start the trains easily, and for this reason the live steam is admitted to the cylinders during 80 to 87 per cent of the stroke. As the speed increases it is necessary to reduce the admission period, thereby increasing the expansion of the steam; therefore for any speed there is some point for the valves to cut off the live steam, at which the engine will develop its maximum power. There is also some minimum velocity at which the full horsepower of the locomotive is attained; after this velocity is reached the horsepower remains constant or slowly decreases. This critical point may be taken at 700 ft. to 1,000 ft. per minute piston speed.

Instead of the old arbitrary method of designing locomotive heating surface by cylinder ratios, the idea of using the cylinder horsepower suggested itself as forming a very desirable basis for the heating surface, grate area and tube area. Curves were prepared from the most recent available data showing speed factors or drop in M. E. P. in relation to velocity. With saturated steam the average maximum horsepower is reached at about 700 ft. piston speed per minute, speed factor .412; constant horsepower is obtained at 700 to 1,000 ft. piston speed, and the horsepower decreases slightly at higher velocities for average conditions when engines are especially constructed for the highest speeds. For superheated steam the average maximum horsepower is reached at 1,000 ft. piston speed, speed factor .445, and constant horsepower at higher speeds. Because the horsepower is based on piston speeds, the stroke and diameter of wheels are omitted in the following figures, the calculation becoming by cancellation:

$$\frac{.85\,P \times .412 \times 1{,}000 \times 2\,A}{33{,}000} = \frac{1.7\,P \times .412 \times A}{33} = .0212 \times P \times A$$

$$HP. = .0212 \times P \times A$$

in which A = area of one cylinder in square inches.
P = the boiler pressure.
.412 = speed factor.

In a similar manner the horsepower calculation for superheated steam becomes:

$$HP. = .0229 \times P \times A$$

using .445 as the speed factor.

The maximum horsepower can sometimes be increased when the locomotive is operated under the most favorable conditions. It is considered safer and better practice, however, to take figures which represent average conditions rather than the abnormal and unusual figures obtained when all conditions are most favorable.

The horsepower basis affords many additional advantages in designing locomotives. For instance, in determining the maximum amount of water and coal required per hour, the size of the grate is found to be proportional to the amount of coal that can be burned to the best advantage, to be varied according to the quality. Knowing the amount of coal required per hour directs attention to the question of hand firing or the use of a mechanical stoker. Knowing the amount of water evaporated per hour determines the location of water stations, size of tender tank, the size of injectors and safety valve capacity, also the size of steam pipes and other features of the boiler. Through the stack a mixture of gas and exhaust steam is ejected at substantially the same velocity for all locomotives in similar service, and proportional to the amount of coal burned. For this reason the area of the stack may be taken as proportional to the maximum amount of coal burned per hour in the firebox.

As a result of the investigations, conclusions have been arrived at as follows:

Firebox Evaporation.—An evaporation of 55 lb. per square foot of firebox heating surface, combustion chamber and arch tubes has been adopted. The greater absorption of heat by the firebox than by the rear portion of tubes per unit of area is largely due to radiant heat. This varies as the square of the distance from the surface of the fire to the sheets separating the gases from the water. Again, it is probable that within certain limitations the amount of heat absorbed is independent of the heating surface and is a function of the grate area or the area of the bed of live coals. Assuming that there is sufficient heating surface to absorb the radiant heat, it is probable that very little additional heat will be absorbed by increasing the firebox heating surface. It therefore follows that the relatively greater area of the fire in proportion to the absorbing surface in wide firebox locomotives is more efficient than in the old narrow firebox.

Diameter, Length and Spacing of Tubes.—The evaporative value in pounds of water per square foot of outside heating surface has been approximately calculated for 2 in. and 2¼ in. tubes, and for superheater flues 5⅜ in. and 5½ in. The range of length is 10 to 25 ft., and the spacing 9/16 in. to 1 in. The best data available shows that the evaporative value of a tube or flue varies considerably with differences in length, diameter and spacing. The curves of temperature compared with length have been used as a basis for determining the evaporation for different lengths of tubes and flues. The rate of evaporation on this basis will vary directly as the difference

of temperature of the tube or flue gases and that of the steam contained in the boiler.

Tubes and flues from 10 to 24 ft. long, spaced 9/16 in. and 1 in. apart, outside diameter 2 in., 2¼ in. and 5½ in. will evaporate from 7.50 to 14 lb. of water per square foot per hour.

Grate Area.—The grate area required for bituminous coal is based on the assumption that 120 lb. of coal per square foot of grate per hour is a maximum figure for economical evaporation. While 200 and 225 lb. have at times been burnt in small, deep fireboxes and the engines made to produce sufficient steam, it is wasteful of fuel and it has been found after numerous and careful tests that the evaporation per pound of coal under these conditions is very low. If, on the other hand, the rate of combustion is too slow, economical results will not be produced owing to the fact that at least 20 per cent of the coal burned produces no useful work in hauling trains, but is consumed in firing up, waiting at roundhouses or terminals, on sidetracks, or to the fact that the greater portion of the time locomotives are used at considerably less than their maximum power.

For hard coal the grates should be proportioned for a range of from 55 to 70 lb. of coal per square foot per hour, according to the grade of the fuel.

Complete tables of horsepower for saturated and superheated steam, evaporation of tubes and flues of various lengths, diameters and spacing, as well as diagrams of temperature for different flue lengths, have all been prepared to facilitate the calculations in determining the proportions of grate, firebox, tube and flue heating surface.

It must be remembered, however, that the boiler capacity for a locomotive when other things are in proportion cannot usually be made too large within the permissible limits of weight, and it can be shown by numerous tests that such increase in boiler capacity makes for considerable economy in the use of fuel and steam. For passenger service the boilers may often be made with advantage over 100 per cent.

In a general way, a boiler will have ample steam making capacity if proportioned by this method for 100 per cent, provided the grate is sufficiently large and deep so that the rate of combustion at maximum horsepower does not exceed 120 lb. of coal per square foot of grate per hour for bituminous coal of average quality. For gas coal a smaller grate may be used, but it is better practice to use the larger grate and brick off a portion at the front end in order to obtain sufficient volume of firebox for proper combustion, because nearly all modern locomotives are deficient in firebox volume.

C. D. Young, Engineer of Tests, Pennsylvania Railroad.—On the Pennsylvania Railroad it is believed that the tendency at the present time should be to increase the firebox heating surface, as it should be realized that it is of comparatively greater effectiveness at mean and low rates of working than the remaining surface of the boiler. Some few years ago when large boilers were designed the tendency was to make the ratio of the firebox to the total heating surface less than 6 per cent. This resulted in locomotives which, although efficient in evaporation, were not free steaming, as they lacked capacity unless very heavily drafted. It is my opinion that the firebox heating surface should be at least 7 per cent of the total heating surface of the boiler, in order to provide a free steaming locomotive, and that when this ratio is satisfied, good results will follow, provided the tube heating surface has been properly proportioned. When working the boiler at high rates of evaporation, however, the tube surface is fully as effective as firebox surface, and for large capacity a large tube heating surface is necessary.

We do not agree with the recent tendency toward excessively long tubes, as beyond a certain length of tube there is too great a sacrifice of boiler capacity in the interest of economy in coal. The long tube presents a very serious obstruction or resistance to the flow of the gases, and beyond a length which appears to be about 100 internal diameters, this obstruction increases without a corresponding increase in evaporation. The locomotive with a long tube is a slow steamer and a higher draft must be furnished in order to create an active fire. This rule that the length of tube should be 100 times the internal diameter has been applied to three new classes of our locomotives with exceedingly gratifying results, and confirms the earlier experiments which were made by us upon this subject, as well as those made by M. A. Henry, of the Paris, Lyons & Mediterranean Railway of France.

FAN DRAFTING AS APPLIED TO LOCOMOTIVES

H. B. MacFarland, Engineer of Tests, Atchison, Topeka & Santa Fe.—The method of drafting a locomotive with its exhaust steam has varied in detail only during the long period of development of the steam locomotive. The basic principle is exactly that of 50 or 60 years ago. The exhaust from the engine was early utilized to produce the necessary draft and is commonly so used today.

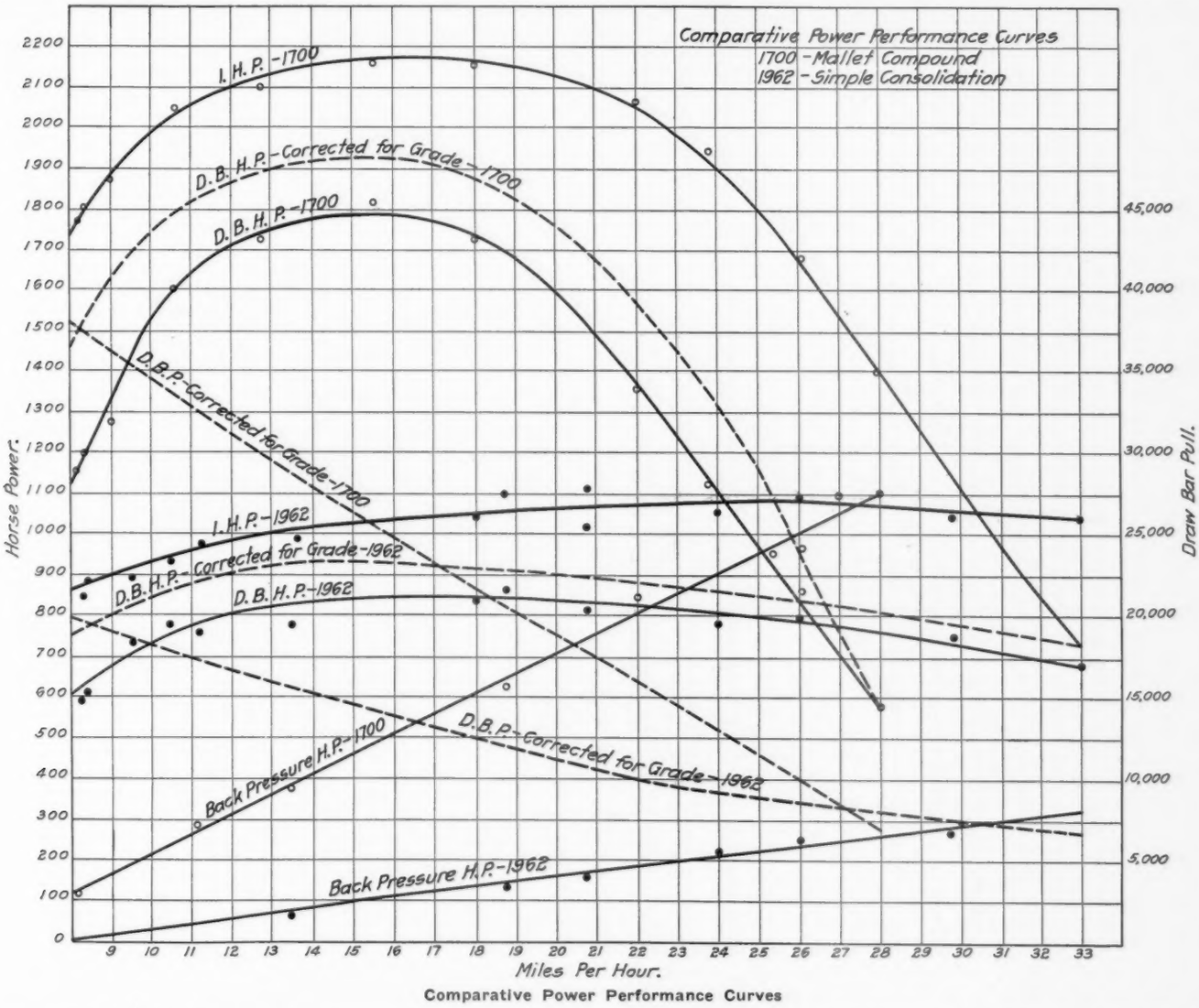
The magnitude of the loss due to back pressure as it existed in representative locomotives on the Atchison, Topeka & Santa Fe was shown in a paper presented by the writer at the fourth annual convention of the International Railway Fuel Association* in May, 1912. The material was collected from a large number of locomotives in actual service operating under greatly varying conditions and showed conditions existing at that time. A general statement is drawn based on tests conducted on 18 different locomotives representing as many different types, working under such varied conditions as are encountered upon the Santa Fe system, with territory extending from Chicago to the Pacific Coast, and presenting at one place or another most of the conditions encountered in railway service. This statement shows that for every 100 horsepower used as actual tractive effort, there are 66 horsepower wasted through the exhaust, over 70 per cent of which may be credited to the excessive back pressure necessary to produce draft for the locomotive boiler. A study of the facts has led the writer to the consideration of a more economical method of drafting locomotive boilers.

Comparative power performance curves for locomotives 1,700 and 1,962 are shown in one of the illustrations. These curves are plotted as a result of data obtained during comparative tests on these locomotives on the third district, Arizona division, between Barstow and Bakersfield, Cal., a distance of 140 miles, in the winter of 1909. Locomotive 1,700, a Mallet compound (2-8-8-2), fitted with a Jacobs-Shupert firebox, Buck-Jacobs superheater, and feed-water heater, cylinders 26 in. and 38 in. by 34 in., had a tractive effort of 108,000 lb. Locomotive 1,962 was of the simple consolidation (2-8-0) type, fitted with Baldwin superheater, cylinders 24 in. by 32 in., and had a tractive effort of 49,500 lb. These curves are presented because they show the enormous back pressure horsepower loss which is an inherent defect in the Mallet type locomotive. The curves show that the maximum power of the Mallet was developed at a speed of approximately 17 miles an hour and that drawbar horsepower and back pressure horsepower equalized at a speed of approximately 25 miles per hour, showing that at this speed the locomotive exerted 950 drawbar horsepower and that an equal power was required to draft the boiler. The curves for the consolidation type show that the maximum power of the locomotive was developed over a wide range of speeds and that back pressure horsepower was not appreciable except at high speed.

The data accumulated from a great many tests conducted over the various divisions of the Santa Fe system, have shown the desirability for some other method of furnishing draft for locomotives to supplant that now commonly used.

*Reported in the *American Engineer*, June, 1912, page 300.

These tests have forcibly demonstrated the inefficiency of the present arrangement when viewed from a thermodynamic standpoint. The chief advantage in favor of the present arrangement is that it is very efficient, speaking from a purely mechanical standpoint; that is, it is free from any complicated parts which are liable to get out of adjustment and does its work when once it has been set up with very little attention other than minor adjustments to keep it in good working order. It is this feature alone that has enabled the present front end arrangement to exist to the present day. In view of existing conditions, attention was attracted to the possibility of drafting a locomotive by some method of forced or induced draft, but because of the impracticability of installing a system of forced draft on a locomotive, except possibly in the case of stoker-fired locomotives where it is not necessary to open the fire door, this form of draft was abandoned and attention directed to the adaptation of induced draft for the purpose. It is a well known fact that induced draft has been successfully applied in stationary and marine service, and its development in these fields has been rapid during the past few years, so that we now have many installations of this character. The development of the steam turbine and progress in the theory and construction of centrifugal fans for this work has added much to the progress made and it seemed logical that if the system could be so successfully applied to other fields, it would find ready application to the locomotive.

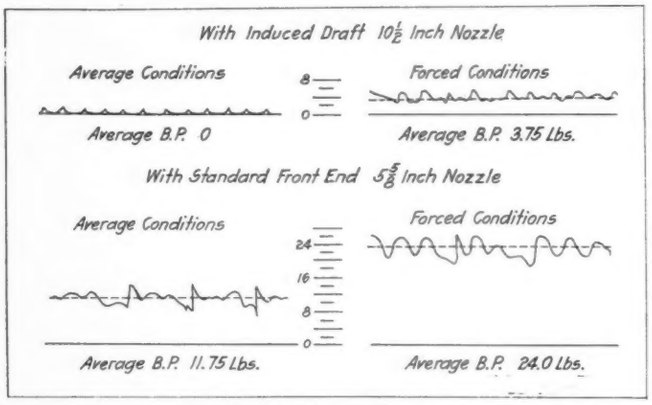

Comparative Power Performance Curves
1700 - Mallet Compound
1962 - Simple Consolidation
I. H. P. - 1700
D. B. H. P. - Corrected for Grade - 1700
D. B. H. P. - 1700
D. B. P. - Corrected for Grade - 1700
I. H. P. - 1962
D. B. H. P. - Corrected for Grade - 1962
D. B. H. P. - 1962
D. B. P. - Corrected for Grade - 1962
Back Pressure H. P. - 1700
Back Pressure H. P. - 1962
Horse Power.
Draw Bar Pull.
Miles Per Hour.

Comparative Power Performance Curves

The problem, however, was not as simple as it at first appeared. Although there were many existing installations of induced draft, and several manufacturers making a specialty of these installations, yet they were not readily adaptable to the locomotive. In power plant and marine service the space occupied by the draft apparatus is not as important an item as with the locomotive. When the problem of furnishing draft apparatus of this character was presented to the manufacturers, they were able to calculate the size of the fan and the horsepower necessary to drive it to burn the required amount of coal per hour, but when the space that such an apparatus would occupy was taken into consideration, they were astounded, and were not able to furnish either data or apparatus satisfactorily to meet the requirements. For this reason it was absolutely necessary to start in at the beginning and develop such an apparatus.

The first step in the development was to secure data showing just what could be expected in draft obtainable, in fuel consumption, in boiler efficiency, and in power requirements to operate a fan draft system. Locomotive 932 was secured for experimental purposes and an experimental plant constructed to secure the data. The test was confined to the boiler of the locomotive with a 48-in. ventilating fan attached to the smokebox. No attempt was made at this time to run the engine on the road. Connection was made between the inlet of the fan and the smokebox of the locomotive so that the exhaust was through the fan rather than through the ordinary

stack. The fan was driven by means of a 25-horsepower constant speed motor, belt connected. The variation in speed at which the fan was driven was accomplished by changing the diameter of the pulleys. The power necessary to drive the fan at various speeds was accurately determined by measuring the current necessary to drive the motor. With this arrangement a series of tests were made in Topeka, Kan., in February, 1912. A maximum of 3,350 lb. of coal was burned per hour, and a maximum of 830 boiler horsepower was developed. This was accomplished at an expenditure of 20 horsepower required to drive the 48 in. fan at an average speed of 715 revolutions per minute; the maximum draft in the smokebox was 2⅞ in. of water. The first tests in the series were made with the diaphragm in place in the smokebox, but this was removed during the later runs and it was found that with the fan draft it was possible to get a very



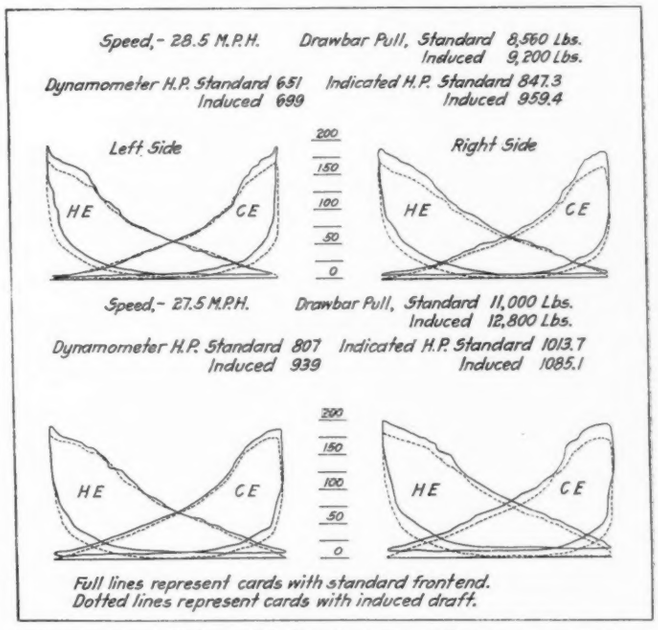
Exhaust Cavity Diagrams

uniform distribution of the draft without employing deflector plates of any kind. It was not possible to develop anywhere near the maximum boiler horsepower with this installation, but valuable data were secured for use in the construction of an experimental unit for drafting purposes.

From the data obtained from these preliminary tests with the 48 in. fan applied to both coal and oil burning locomotives, an experimental unit adaptable to locomotives was furnished by the manufacturers and delivered to Topeka in September, 1912. This unit consisted of a stock 24-in. fan with special provision for direct connection to a 40 horsepower steam turbine, the entire apparatus being so constructed as to be a compact unit suitable for application in the ordinary smokebox of a locomotive. Preliminary tests were made with this unit, during which the volume of air at atmospheric pressure and temperature, discharged at various turbine speeds, was determined when the fan was operated against various resistances simulating locomotive service. These tests indicated that the fan was of sufficient size for the locomotive for which it was ordered, so that application of the apparatus was made to locomotive 1,302 at Topeka shops in January, 1913. The first actual test of the apparatus installed on this locomotive was made on January 12, 1913. It was soon apparent that the 24-in. fan did not have the capacity to furnish the necessary draft, and it was not until after a great deal of experimental work, during which it was necessary to design and build three fan rotors and make modifications of the fan casing, that a fan of sufficient capacity was secured to permit of actual road tests. During the development of these fans, however, several stationary and road tests were made with the locomotive, during which valuable data were secured.

Prior to tests with the fan draft apparatus, complete tests of the locomotive with the standard front end arrangement had been made for a basis of comparison of results obtained with the two arrangements. Typical indicator cards secured under the various conditions show the possibilities of the fan draft in eliminating the back pressure of the engine. While the fan used during the later series of tests was not mechanically correct or of sufficient capacity to develop the maximum power of the locomotive, it was of sufficient capacity to bring out many valuable points relative to the general performance to be expected from a system of this kind. The locomotive burned its fire as satisfactorily with the fan draft arrangement as with the standard front end arrangement, and there was no more tendency for the fire to bank or clinker. A uniform draft varying from 4 in. to 6¼ in. of water was maintained with the fan draft.

The capacity of the fan was limited to the maximum safe speed at which it could be run, and when the demand upon the boiler was such that it could be supplied with the draft available within the maximum speed of the fan, there was an economy shown. This was evident when the locomotive was working on grades, where, although more steam was used per stroke, the relatively low speed of the locomotive made the total steam consumption lower than on the level stretches where less steam was used per stroke, but the higher speed and consequent increase in the number of strokes per unit of time, placed a demand for steam on the boiler which could not be supplied by the draft available with the fan. For this reason, it was not possible to maintain full boiler pressure at all times with the fan draft arrangement, so that the initial pressure available in the cylinders was from 12 lb. to



Indicator Cards Taken with Standard Front End and with Induced Draft

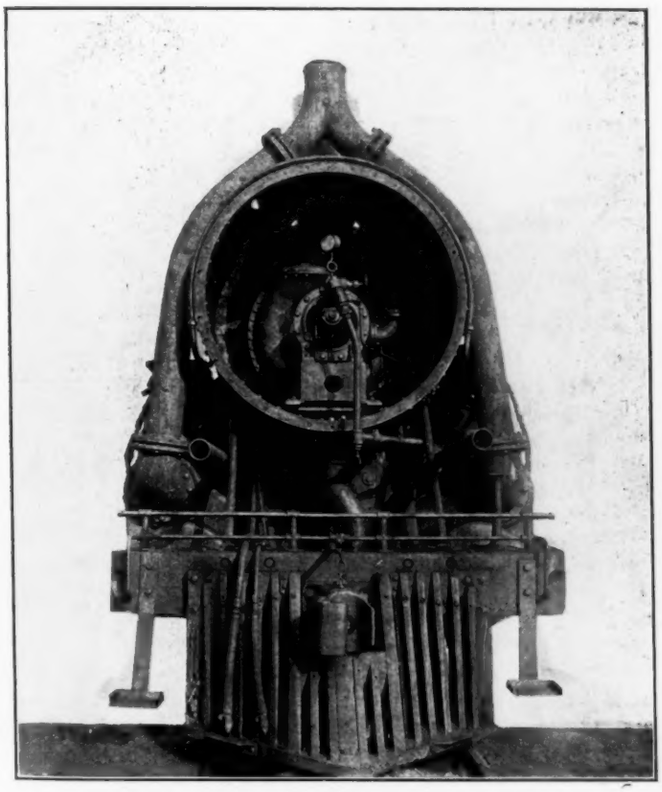
13 lb. lower from runs with the fan draft than runs with the standard front end arrangement. Analyses of the indicator cards show that although there was a gain in power as indicated by an increased area at the bottom of the cards, there was a corresponding decrease at the top of the card. This was due to the difference in initial pressure, so that the gain in power due to the elimination of the back pressure was just about sufficient to operate the fan draft apparatus, and there was no apparent gain in the over-all efficiency of the locomotive. This is demonstrated by the indicator cards shown.

A comparison of the performance of the locomotive under the two systems of drafting during periods in the runs when such comparison is at all possible, that is, when working conditions are similar, is favorable to the induced draft arrangement. Such a comparison based upon the actual power de-

livered at the drawbar shows a saving of nearly 20 per cent in fuel for the fan draft, and it is entirely possible to effect a marked saving in indicated horsepower with it.

Typical exhaust cavity cards are shown in one of the engravings. These pressure readings were taken in the exhaust cavity of the valves by means of an independent indicator fitted with a 20-lb. spring. They were chosen to cover the entire field as nearly as possible.

The conclusions drawn from these comparative tests were that it is entirely possible to draft a locomotive boiler by means of an induced draft fan to replace the exhaust tip commonly used; that it is possible to entirely eliminate the cylinder back pressure under normal conditions and greatly reduce it under forced conditions of operation of the locomotive; that with equal steam chest pressures, cut-offs, and speeds there is an appreciable increase in indicated horsepower due to the elimination of the cylinder back pressure, and that it is entirely possible to successfully operate an installation of this character at the necessary high speed during



Arrangement of the MacFarland Fan Draft

intervals of time representing a run over the average division of a railroad.

The logical field for locomotive mechanical draft is upon compounds in general and Mallet compounds in particular, where the excessive back pressure results in more pronounced cylinder losses. The development of this branch of locomotive engineering will necessarily be gradual, on account of the absence of data or lack of experience on the subject.

The experience with the fan draft gained from actual tests led to the development of an automatic control system to govern or regulate the speed of the turbine, and consequently regulate the intensity of the draft. It was found that it was highly desirable to make the operation of the fan as nearly automatic as possible and not have to depend on the engineer or fireman to regulate its action. At the same time, its operation should be under the control of the fireman at all times should he choose to exercise control. The essential features of the automatic control system which have been developed are the provision of both maximum speed and pressure governors and an arrangement which insures the starting of the turbine at the time the main locomotive throttle is opened, and shutting off when the throttle is closed. In addition to these features, an independent steam line is provided which makes possible the operation of the turbine at nearly its maximum speed when the locomotive is standing.

The maximum speed governor is made a part of the steam turbine itself and is designed to automatically throttle the supply of steam into the turbine when the pre-determined maximum safe speed has been reached. The maximum pressure governor is fitted into the steam line supplying the turbine and is so constructed that the flow into the turbine is automatically throttled when the locomotive boiler pressure has reached within a few pounds of the normal working pressure. This governor is also fitted with an attachment which makes possible the control of steam through the valve from the locomotive cab.

LOCOMOTIVE FRONT ENDS AND DRAFT APPLIANCES

C. D. Young, Engineer of Tests, Pennsylvania Railroad.—There has been a tendency of late to use exhaust nozzles having other than circular openings. The plain circular nozzle forms a steam jet which is too nearly cylindrical, or the shape of the stack, and the use of such a shape as the rectangular appears to break up the continuity or the form of the jet and cause it to draw out a larger volume of gases. Both rectangular nozzles and nozzles of the dumb-bell shape have been used with success, and with an increase in evaporation over that with the circular form. There has recently been developed on our locomotive testing plant a nozzle having four internal projections which appears to be more satisfactory than some of the irregularly formed nozzles. With these nozzles, having other than a circular outlet, an increase in the evaporative capacity of the boiler of from 15 to 25 per cent has been obtained and in recent tests on a large Pacific type locomotive a nozzle with four internal projections has given a maximum capacity in equivalent evaporation from and at 212 deg. of 87,414 lb. per hour. In the locomotive in question, this is an evaporation of 18.0 lb. of water per square foot of heating surface per hour and with this quantity of steam an indicated horsepower of 3,184 was obtained; whereas, the circular nozzle on this same locomotive developed a maximum equivalent evaporation of but 62,719 lb. of water per hour, resulting in an indicated horsepower of 2,501. It should be understood that no change was made in the locomotive other than in the exhaust tip.

It has been the practice on the Pennsylvania to require that the air openings into the ashpan be at least 15 per cent of the area of the grate, and when the openings are of this size, the ashpan vacuum will be considerably less than one inch of water at the maximum evaporative rates. We have found, however, in the case of some switching locomotives, that this area of 15 per cent of the grate area has been too large for the requirements of their service and to provide for this condition upon shifting locomotives, ashpan dampers have been installed along the air inlets at the mud ring. This arrangement very nicely takes care of these locomotives, which stand a great deal of the time, and if the air inlets in the ashpan were not reduced, it would be difficult for the firemen to prevent a large amount of steam from escaping from the safety valves.

C. E. Chambers, Superintendent of Motive Power, Central Railroad of New Jersey.—Two or three years ago we had a new type of locomotive which gave us some trouble. After a number of trials of various expedients it occurred to me that the stack might be too small, so I took up with the locomotive builders the question of the relation of the diameter of the stack to the diameter of the cylinder, and it was admitted by them that the stack was smaller than it should be. We increased the diameter from 15 in. to 18 in. at the choke. We had perhaps one hundred or more engines with the same size stack, and about the same

cylinder volume, but not in the same kind of service, so that they did not give us much trouble. But after making these changes on this particular type we made the change on the other engines and found a decreased consumption of coal.

One small improvement we have made in smokebox fronts where there is trouble from overheating is the placing of a liner about 4 or 5 in. away from the smokebox door, and filling the space with asbestos. This entirely eliminated the overheating.

COMBUSTION IN LOCOMOTIVE FIREBOXES

J. P. Neff, vice-president American Arch Company.—All modern locomotives, or at least practically all those built in the last few years, have been built to haul heavy steel passenger trains on hard schedules or to meet exacting conditions in other kinds of service. As the locomotive itself has been greatly improved and refined in the last ten years, so has this special device, to the end that it has been shorn of many of its original faults, leaving its never disputed virtues standing out all the more prominently. The brick arch insures more nearly complete combustion. The combustion of high volatile coal at the rapid rates necessary to meet the demands for large hauling capacity today is fraught with considerable losses due to incompleteness. That represented by the CO content in front end gases is only a part of it. The losses from the incomplete combustion of hydro-carbons may easily be four times that represented by the CO per cent in the gas analysis. Anything that will mitigate these losses without introducing too high air excess reflects at once in higher furnace temperatures. The introduction of the combustion chamber helps by lengthening the flame travel, but the introduction of the arch, especially the arch on water tubes, not only doubles the average length of the flame travel, but possesses the more important virtue of being a mechanical mixer.

By fostering or enhancing combustion above the fuel bed in this way considerably more heat is evolved and higher firebox temperatures result. Authentic tests have shown that with certain coals this increase in firebox temperature may be 15 per cent; yet, as a rule, these higher firebox temperatures are not accompanied by higher front end temperatures. This is explained by the fact that the tube supported arch by virtue of its position performs another important function, that of forcing these higher temperature gases to sweep or brush at considerably increased velocity a considerably greater area of evaporating surface; not only the added area of the arch tube surface, but much surface of hitherto unswept firebox plate, so that the double result is accomplished, of creating more heat, and causing to be absorbed this increased amount of heat, giving a net result of increased boiler output for the same amount of coal consumed, a distinct advance or rise in the boiler efficiency.

The circulating tubes or arch pipes play no small part in this. Not only do they present by far the most effective heat-transmitting surface, but the circulating effect in itself is very important, especially at high rates of evaporation. Just as the particles of gases must quickly touch the heat absorbing surface and give way instantly to other particles, so must the water, or steam film, on the opposite side of these surfaces give way quickly to other particles of water, if a high rate of heat transfer is to be accomplished. Expedited circulation will insure this favorable condition. A locomotive boiler can no more give high duty per pound of weight or square foot of heating surface when the gases move leisurely over its surfaces and through its tubes than can the locomotive as a whole give high horsepower in a slow turning of the wheels.

J. T. Anthony, Manager Service Department, American Arch Company.—High firebox evaporation means high boiler efficiency, for the high heat absorption by the firebox reduces the temperature of the gases entering the tubes; and for any one boiler, the temperatures of the gases entering and leaving the tubes are directly proportional when reckoned above steam temperature. Hence a lower temperature of entering gases means lower front end temperatures and an increase in efficiency.

A large percentage of the bituminous coal burns above the grate as gas. The rapidity and completness of the combustion of these gases depends on the amount of oxygen present and the thoroughness of the mixing. In a firebox with 60 sq. ft. of grate, with a rate of combustion of 60 lb. of coal per square foot of grate per hour, an air supply of 20 lb. per pound of coal and an average firebox temperature of 2,000 deg., the volume of the gases evolved is about 1,200 cu. ft. per second. A firebox of this size would have a capacity of about 200 cu. ft., and would have to discharge and be refilled with gases about six times per second. The average time available for combustion of each particle of gas would then be about one-sixth of a second, and this is insufficient for complete and proper mixing by diffusion. With the short time allowed, it is necessary to mix the gases by mechanical means, and this is generally accomplished by an arch or baffle which forces the gases to pass through a restricted area, this area being not less than the net tube area.

It is evident that mere firebox volume is not sufficient of itself, and it is necessary to have a flameway of such cross section and length as to intimately mix the gases and provide sufficient space for burning before the gases reach the tubes. In an ordinary firebox, without baffle or combustion chamber, the average length of flameway is only 5 to 6 ft. By the introduction of baffles and combustion chambers, this length can be increased to from 10 to 15 ft., which results in not only more complete combustion but also in increased radiating surface, with a corresponding increase in firebox evaporation and a lowering in temperature of the escaping gases.

A Pacific type locomotive with 55 sq. ft. of grate area, a tube-supported arch and an average flameway of 8 ft. had an average firebox temperature, covering a range of 25 tests, of 2,100 deg. This temperature was taken at the center of the firebox at about the end of the arch. The gases entering the tubes showed an average of 1,725 deg., or a drop in temperature of 375 deg.

Another Pacific type locomotive with the same size grate and a tube-supported arch, but with a combustion chamber 3 ft. long, giving an average flameway of 11 ft., showed over the same range of tests an average firebox temperature of 2,185 deg., with the temperature of the gases entering the tubes of 1,485 deg., or a drop of 700 deg. between the center of the firebox and the tube sheet.

We obtain high efficiency at low rates of combustion in spite of the large air excess which generally accompanies. This is due to the fact that at low rates the firebox absorbs a larger percentage of the total heat evolved, and the amount so received for any one firebox depends primarily on the temperature of the fuel bed. It is possible that this temperature is higher with large air excess than with the lower, as the temperature is due to the rapidity of combustion which in turn depends upon the scouring and cutting action of the air blast.

The firing clearance, or the vertical distance between the fuel bed and the lower tubes, or arch, has been materially increased by the introduction of modern types of locomotives with trailing trucks, as this has permitted the firebox to be placed behind the drivers and the grates dropped lower. This one step has probably offset to some extent the high ratios between heating surface and grate area which are found in modern locomotives. The extent of the firebox heating surface is determined largely by the size and location of the grate; but there is no fixed relation between heating surface and grate area, or between firebox and boiler heating surface.

As stated above, the firebox evaporation depends primarily upon the extent and temperature of the radiating surfaces and not on the extent of the firebox heating surface. Increasing the firebox heating surface without increasing the grate area or flameway will result in very little increase in evaporation. Its only effect is to reduce the amount of heat absorbed by each unit of surface, with a slight reduction in the temperature on the fire side of the surface. An evaporation of 60 lb. of water per square foot of firebox heating surface per hour requires a

difference of less than 100 deg. between the water and the fire side of the sheet, and if sufficiently high firebox temperatures or sufficiently large radiating surfaces could be obtained, it would be possible to materially increase even this high rate of evaporation without forcing the heating surface to its capacity.

In the Coatesville tests, conducted by Dr. Goss, the two fireboxes gave an evaporation as high as 58 lb. of water per square foot of heating surface per hour; but there was practically no difference in the total amount of water evaporated by each of the fireboxes when working at the same rate of combustion and with the same grate area, notwithstanding the fact that one of them had 12 per cent more heating surface than the other.

Judging from the past, we are not apt to see any radical departures from the present type of firebox in the near future, unless the nature of the fuel is materially changed, and the writer believes that any improvement in the efficiency of this part of the locomotive will be obtained by providing for ample grate area, firing clearance, gas mixing, flameway or combustion chamber space, and air supply.

WHAT THE STOKER HAS DONE FOR THE LOCOMOTIVE

C. F. Street, Vice-President, Locomotive Stoker Company.—The most important accomplishments of the mechanical stoker as applied to locomotives, are the increasing of the earning power of existing locomotives, and the removal of all limitations, from a fuel quantity standpoint, on the size of locomotives.

The locomotive designer should always keep in mind the fact that every dollar earned in the operation of a railway must be earned by its locomotives, and, therefore, I have, in the above, given first place to the increase in the earning power of existing locomotives. I could cite many instances to prove this statement, but as an illustration, will take one:

A locomotive having about 54,000 lb. tractive effort when running with saturated steam, had a tonnage rating over a certain division of 4,750 tons. Superheaters were applied to this locomotive, and the tonnage increased to 5,000; stokers were applied, and the tonnage increased to 5,250; then 5,500; then 5,750, and finally 6,000 tons. In the meantime, the tonnage rating of the shovel-fired, superheated steam locomotives was increased to 5,500 tons. This shows an increase of over 20 per cent in the tonnage rating of this locomotive after the stokers were applied, and the locomotive today, stoker-fired, is hauling 10 per cent more tonnage than when shovel-fired.

The increase in the tonnage rating of the shovel-fired locomotives is very interesting, and brings out strongly one of the indirect advantages of the stoker. Before stokers were applied, the shovel-fired locomotives were not doing anywhere near what they should do, and as soon as the stoker came into use, it increased the earning power, not only of locomotives to which it was applied, but of all others on the division.

The stoker is making it possible to come much nearer to theoretical conditions in regular operation. We all know that there is a wide difference between the earning power of a locomotive under test conditions and under average road conditions. I have in mind one case, in which, under test conditions, it was found that a certain locomotive could haul 4,000 tons comfortably over a certain division. When put in regular service, however, it was found impossible to operate it with more than 3,500 tons over this same division. With the stoker, these locomotives can easily haul 4,000 tons in regular road service.

The fact that the stoker has removed limitations in the size of locomotives can be brought out by reference to several of the locomotives referred to in the committee's report. The Mountain type locomotives referred to were fitted with stokers when they were built, have always been stoker-fired, and no attempt has ever been made to shovel-fire them. One of the locomotives referred to would never have been built had it not been known that a stoker could be secured which would fire it. There are 30 of the locomotives of one class referred to now in regular operation, and they would never have been built had it not been known that a stoker could be secured which would fire them. A number of other locomotives, notably the most powerful Pacific type as yet built, are now in regular operation, and would never have been contemplated without a stoker.

There are today, very few, if any, shovel-fired locomotives in this country having a maximum tractive effort of 50,000 lb. or over, which are being worked to their full capacity. Wherever stokers have been applied, the earning power of the locomotives on which they have been placed has been increased from 10 to 20 per cent. There is no instance where stoker-fired and shovel-fired locomotives are being operated under identical conditions. The stoker-fired locomotives are hauling increased tonnage, using a cheaper fuel, or working at higher average speeds than the shovel-fired locomotives, and are, therefore, earning more money.

E. A. Averill, Engineer of Operation, Standard Stoker Company.—Although the proper firing of a locomotive by hand has reached the stage of a skilled operation and some remarkable records have been made in certain instances, the progress of locomotive development has now almost entirely passed the point where skilled manual firing can properly do the work if the full capacity of the locomotive is to be used.

At a speed in miles an hour equal to about one-half (.476 to .636) the diameter of the drivers in inches, the capacity of most modern freight locomotives is fixed by the boiler capacity. In a report of a test on a large locomotive at the Altoona test plant of the Pennsylvania Railroad, it is stated that the results indicate that the capacity of the boiler was limited by the ability to burn the coal on the grates and not by any failure of the heating surface to absorb the heat supplied. While in this case the limit was marked by the impossibility of supplying sufficient air through the grates to properly burn the fuel, there are a reasonably large number of locomotives operating in this country today which are running at less than full boiler capacity because of the physical inability of the fireman to supply the amount of fuel that can be burned. These locomotives are giving to the drawbar the pull which the man can supply but not what the locomotive is capable of supplying at the desired speed.

I have selected at random ten classes of locomotives built during the past three years which are typical of the general size and capacity of all the larger freight engines built in that time. These are shown in the accompanying table. The American Locomotive Company's standard practice in connection with steam per horsepower hour and evaporation per pound of coal has been used; also the percentage of tractive effort and maxi-

									On grade of .05 per cent					
Type.	Cylinders, In.	Steam Pres., Lb.	Diam. Driv., In.	Max. Tractive Effort, Lb.	Max. Cyl., Hp.*	Normal Hp. from Heating Surface†	Coal per Hr. at Max. Hp.‡ Lb.	Speed for Max. Hp. Mi.	Speed m.p.h.	Tons in Train	Hp. Req'd	Coal per hr., Lb.	Coal at sq. ft., G. A., Lb.	Water per sq. ft., H. S., Lb.
2-8-2	25 x 32	180	63	48,600	2,027	2,210	6,587	35	25	1,930	1,945	6,320	112	9.88
2-8-2	28 x 32	170	63	57,460	2,400	2,310	7,507	35	25	2,382	2,290	7,440	106	11.5
2-8-2	27 x 30	175	63	51,700	2,296	2,269	7,374	37.5	25	2,183	2,160	7,020	100	11.05
0-8-8-0	26 & 41 x 28	200	51	105,000	.....	3,032	8,759§	32.5	15	6,050	2,860	8,240§	82.4	10.6
4-8-2	28 x 28	185	69	50,000	2,613	2,451	7,965	44	35	1,403**	2,390	7,767	124	12
2-6-6-2	21½ & 34 x 32	200	57	67,500	2,533	2,312	7,514	32	15	3,820	1,940	6,300	111	9.2
2-8-2	28 x 32	180	64	60,000	2,542	2,418	7,858.5	36	25	2,470	2,410	7,840	100	10.8
2-8-0	26 x 30	185	57	55,900	2,251	2,167	7,242	34	15	3,210	1,765	5,750	86	10.4
2-8-8-2	26 & 40 x 30	200	57	87,600	.....	2,942	9,561	34	15	5,060	2,390	7,800	92	9.2
2-8-0	25 x 30	180	57	50,328	2,027	1,848	6,006	34	15	2,920	1,510	4,900	87	11

*Horsepower + .01798 Pd² at 1,000 ft. piston speed. †Normal horsepower from heating surface = evaporation, lb. per hour ÷ 20.8 lb.
‡ 3.25 lb. coal per horsepower hour. § 7.2 lb. water per lb. of coal. ** Passenger train.

mum horsepower at various piston speeds and the evaporation per square foot of heating surface for the firebox and tubes. It is assumed that each locomotive is working at the speed indicated on a .5 per cent grade, and that the cars in the train each weighs with lading 70 tons.

When delivering the power each of these locomotives is easily capable of giving, if in good condition, it will be seen that they require from 4,900 lb. to over 8,000 lb. of good quality coal an hour. Similar calculations for grades of less rise will show a higher speed and greater coal requirements per hour.

It is evident that these engines, with the possible exception of the last one, are not being supplied with this amount of coal, although they could use it if they were. They are actually getting from 4,500 to 5,000 lb. an hour and handling trains of a proportional size. The last one on the list is included to show the size that lies near the dividing line between hand and stoker-firing. These ten examples are typical of the ones referred to as giving the drawbar pull the man can supply, but not what the locomotive is capable of supplying.

A number of locomotives like these, all of the same class and operating on the same division, will have a tonnage rating in proportion to the ability of the average poorest fireman that is assigned to them rather than of the average best fireman. While there may be a few firemen on the division who are capable of developing the full boiler capacity, the group of engines as a whole may be daily working much below their actual capacity. The acceptance of the opportunity to supply the desired quantity of coal at all times to these locomotives, that is offered by the stoker, will have the same practical effect on operating expense as would a new order of more efficient, larger locomotives. A reduction in the cost of conducting transportation follows this increased locomotive capacity in a number of the principal items when presented on a ton-mile basis. The stoker itself offers an opportunity for further saving, particularly in the cost of fuel, reduced claims for damage or accident, and the recruiting of men of higher caliber for locomotive service.

An instance of the possible savings in the cost of conducting transportation through increased locomotive capacity following the application of a stoker, is found on a certain division where ten tonnage trains are sent one way over the road each day with hand-fired locomotives. Application of stokers has permitted an increase of over 11 per cent in the tonnage of a train. The return movement is largely empties. The application of stokers will give a direct saving in wages and train supplies alone of about $100 per engine a month on this division. If advantage is taken of the increased capacity of the division for tonnage without adding locomotives, the saving will be larger.

FEED WATER HEATING

H. H. Vaughan, assistant to vice-president, Canadian Pacific, stated that considerable has already been heard as to the experiments made on feed water heating by Mr. Trevithic on the Egyptian railways, in which he used not only exhaust steam heaters, but waste-gas heaters in the front end. With the latter he has been able to put the water into the boiler at 230 deg. and obtain 22 per cent economy. In this country the Central Railroad of Georgia has done a little with feed water heaters, as well as the New York Central, the Canadian Pacific, and the Central Railroad of New Jersey.

"On the Canadian Pacific we have been experimenting with feed water heating for six years. We have tried open heaters in a tank with fairly good satisfaction. We also applied exhaust steam injectors, and got fair results. We have since been advised by the manufacturers that our troubles were because of our having applied an injector of too large size for ordinary work on the engine. However, I am of the opinion that while the exhaust steam injectors would work fairly well under certain conditions, yet there would be some difficulties where the amount of water consumed is large. We found on experiments with an open heater that the temperature obtained was due to the exhaust steam from the feed pump, so, assuming a temperature of 200 deg. in the feed water, it would really be the equivalent of 160 deg. when the water was put into the boiler by an injector with 100 per cent efficiency. By heating the water at the injector suction to 120 deg., we got 6 per cent economy, and used injectors as against 10 or 12 per cent economy with the feed water heater, and using a pump. We thought 6 or 7 per cent with the injector was preferable to 10 or 12 per cent with the pump, and we have been experimenting on that in recent years with reasonable results. Lately we have experimented with an ordinary closed feed water heater, and it is giving fair results.

"This is a subject which American railroad people have largely neglected. It has the advantage of not only saving in coal, but increasing the capacity of the boiler. In careful experiments we found an economy of 12 per cent in the use of the heater, and we feel that that justifies our going into the device more thoroughly. I feel that we will see feed water heating coming into larger use, not only with exhaust steam, but with waste gas."

F. F. Gaines, superintendent of motive power, Central of Georgia, said in part: Feed water heating in this country is confined to a limited number of cases, and cannot be said to be generally recognized as a factor in fuel economy. Experiments made on several engines show that about 10 per cent economy can be expected; there have been, however, offsetting difficulties in maintenance.

The feed water heater in question was made up of two elements. The first consisted of a pair of condensers in the form of long drums applied underneath the running boards. The steam from air pumps, boiler feed pumps, and some of the main exhaust was condensed in them and the heat taken up by the feed water. The second element consisted essentially of a double nest of tubes in the smokebox, similar to a Baldwin type superheater. The feed water from the tank was forced through the condensers and smokebox heater, and from the heater through the regular boiler checks.

Some trouble was experienced with operation of the pump, and it was also found that the type of pump used was not altogether suitable for the purpose, wearing very rapidly and having considerable slippage. The smokebox heater tubes were objectionable from the standpoint of obstructing draft and filling up with soot and cinders between the tubes, also cutting out very rapidly by the action of the exhaust. There was a further objection due to the fact that the condensed steam from the air pumps and boiler pump exhaust was still at a temperature that, in cold weather, would give off considerable clouds of steam, and as this water had to be wasted, the result was a cloud of steam around the engine, which was objectionable because of obscuring the view of the engineman in looking back over the train.

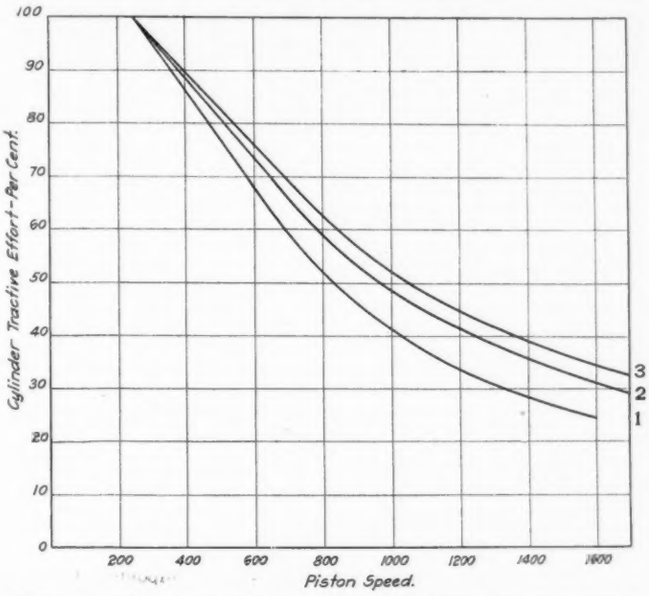
These heaters were used some two or three years, however, and tests were made which showed them to have a fuel economy somewhere in the neighborhood of 10 per cent.

LOCOMOTIVE SUPERHEATERS

Geo. L. Bourne, Vice-President Locomotive Superheater Company.—The locomotive boiler, when considered for the application of a superheater, presented many limitations that necessarily have an important bearing on the design and construction of the superheater. These limitations are more readily appreciated when it is remembered that the development of the locomotive, within certain fixed side and overhead clearances, has been dependent on the size of the boiler; that is, as the size of the locomotive has grown, each pair of wheels has been added to obtain proper weight distribution in order to accommodate increased boiler sizes. As a natural consequence of these conditions, the boiler is no larger than is absolutely necessary; in fact, in the majority of cases it is insufficient in evaporating surface.

The application of the superheater to this boiler, frequently

inadequate as to heating surface, necessitates a reduction of about 15 or 20 per cent in the tube heating surface. This is occasioned by the use of the large flues in which the superheater units are located. Furthermore, a certain percentage of the gases which formerly were all available for evaporation



Curves Showing Possibilities of Increased Capacity from Superheating

of the water must now be used for superheating the steam, since the superheater does not provide for any increase in the maximum rate of combustion. Taking this boiler with its deficiencies, the superheater designer has been able to produce an economy of 25 per cent in fuel, as a direct result of saving one-third of the total water evaporated per unit of power developed. This has resulted in greater locomotive capacity.

As an illustration of this fact, the accompanying diagram is presented. It shows cylinder tractive effort in per cent plotted against piston speed. The lowest curve, No. 1, very fairly represents the speed factor for an average saturated steam locomotive. Curve No. 2 similarly represents the average modern superheated steam locomotive, using between 200 and 250 deg. of superheat. The greater tractive effort available is due to the fact that a longer cut-off is possible with the superheater engine at comparative speeds. The limiting factor at the usual speeds is the ability of the boiler to furnish steam.

These results have been accomplished in the face of boiler limitations, parts of the locomotive not adaptable to the use of highly superheated steam, and lack of experience in the organization which must handle the locomotive. The problems incident to these conditions are rapidly being worked out, and results shown by the superheated steam curve will soon be as basic as the saturated steam locomotive curve was a few years ago. The future then holds a possibility for further saving by increasing the degree of superheat.

The superheater engineer has only made use, thus far, of the same variety of flue sizes as was used by the locomotive designer for tube sizes. If the superheater designer is permitted the use of a size different from the two present standards, it is possible to obtain in a superheater boiler an evaporating surface practically as great as in the saturated steam boiler. The superheating surface in this case will be a net gain to the heat absorbing surface of the boiler. With a boiler and superheater thus arranged, a greater capacity may reasonably be expected, and a curve approximately that shown as No. 3 may be confidently looked forward to in the near future. For some time past large passenger locomotives have been operated very successfully with steam chest temperatures running between 750 and 800 deg. F. Curve No. 3 is representative of locomotives using this degree of steam chest temperature, which means 350 to 400 deg. of superheat.

HEAT TREATED AND ALLOY STEELS

C. D. Young, Engineer of Tests, Pennsylvania Railroad.—With the ordinary annealed carbon steel as used generally for locomotive forgings, such as axles, crank pins, side rods, etc., the minimum physical properties may be considered to be as follows:

Tensile strength	80,000 lb. per sq. in.
Elastic limit	½ the tensile strength
Elongation in 2 in.	22 per cent
Reduction of area	30 per cent

With properly quenched and tempered carbon steel we may expect an increase in the elastic limit of 30 per cent or more,

Parts	Grade of Material	Working Fiber Stress, Lb. per sq. in., in Tension or Compression	Working Fiber Stress, Lb. per sq. in., in Bending	Minimum Ultimate Tensile Strength	Minimum Elongation in 2 in.	
Main and parallel rods	Annealed .45 carbon	8,000	10,000	80,000	1,800,000	20 per cent
	Quenched and tempered .52 carbon	10,000	14,000	85,000	T. S. 2,000,000	20 per cent
	Quenched and tempered alloy	12,000	18,000	100,000	T. S.	20 per cent
Piston rods	Annealed .45 carbon	9,000	.....	80,000	1,800,000	20 per cent
	Quenched and tempered .52 carbon	10,000	.....	85,000	T. S. 2,000,000	20 per cent
	Quenched and tempered alloy	12,000	.....	100,000	T. S.	20 per cent
Driving axles	Annealed .45 carbon	Combined bending and torsion in starting	18,000	80,000	1,800,000	20 per cent
	Quenched and tempered .52 carbon		20,000	85,000	T. S. 2,000,000	20 per cent
	Quenched and tempered alloy		25,000	100,000	T. S.	20 per cent
Crank pins	Annealed .45 carbon	.....	13,500	80,000	1,800,000	20 per cent
	Quenched and tempered .52 carbon	.....	16,000	85,000	T. S. 2,000,000	20 per cent
	Quenched and tempered alloy	.....	20,000	100,000	T. S.	20 per cent
Cast steel parts	Annealed .28 carbon	8,000 (Tension)		60,000	1,400,000	22 per cent
	Quenched and tempered .28 carbon	10,000 (Tension)		75,000	T. S. 1,800,000	20 per cent
				Transverse Strength		Bend Test
Springs	Drawn 1.0 carbon	70,000	.....	90,000		25 deg.
	Quenched and tempered 1.0 carbon	90,000	.....	120,000		25 deg.
	Quenched and tempered alloy	100,000	.....	150,000		50 deg.

Note.—Maximum figures for working fiber stress may be 20 per cent in excess of those shown.

about 15 per cent increase in tensile strength, the elongation remaining the same and the reduction of area increasing about 50 per cent. These are conservative figures and a great deal better elastic limit and tensile strength may be obtained, depending upon the chemical composition and the heat treatment.

From alloy steels, such as chrome-vanadium or chrome-nickel, we may expect to obtain the following minimum physical properties after heat treatment:

Tensile strength	95,000 lb. per sq. in.
Elastic limit	75,000 lb. per sq. in.
Elongation in 2 in	20 per cent
Reduction of area	30 per cent

On an average these alloy steels will show an increase in physical properties over those of annealed carbon steel of 20 per cent or more in tensile strength, 80 per cent or more in elastic limit, with elongation in 2 in. about 9 or 10 per cent less than that of the carbon steel, and the reduction of area 75 per cent or more greater. These figures are also subject to considerable variation.

In carbon steel castings approximately the same per cent increases in physical properties as were given for carbon steel forgings may be obtained after proper heat treatment. The experience with alloy steel castings has been too limited to furnish any satisfactory data.

Up to the present the majority of users of heat treated steels seem to have made but little, if any, use of the increased physical properties as determining the fiber stresses used in design, though some of the larger builders of locomotives have made such increases in fiber stresses for both heat treated carbon and alloy steels. In certain parts where heat treated carbon steel has been used, the fiber stress has been increased about 25 per cent above that used for annealed carbon steel, and in the case of heat treated alloy steels an increase of as much as 50 per cent has been made. In some cases, depending upon the design and service for which the forging is intended, it is preferable to allow no increase in the fiber stress, but to consider the excess strength as contributing to increased life in service, or to safety.

Recent practice has indicated that it is desirable, when using heat treated designs, to carefully study the sections, so as to avoid abrupt changes, and also in the case of larger shafts, such as axles or crank pins, that they should be hollow bored in order to provide for better treatment and to relieve shrinkage strains which occur during the quenching process.

While there is no objection to the change of the present standard section, it would seem, with our present knowledge of heat treated material, that it would be entirely safe to use certain increases in the fiber stresses when designing the locomotive parts, and, as a suggestion as to what could be done in this respect, the accompanying table shows what is recommended for three grades of steel as to working fiber stresses and the minimum ultimate strength and elongation. This has been tabulated for .45 annealed carbon, quenched and tempered .52 carbon, and quenched and tempered alloy steels.

Results seem to indicate that heat treated carbon and alloy steels will show greater resistance to wear and to the fatigue stresses in service than annealed carbon steel, and it is our opinion that the increase in resistance to wear is about in proportion to the increase in Brinell hardness.

POSSIBILITIES OF THE FUTURE

J. B. Ennis, Chief Mechanical Engineer, American Locomotive Company.—The large steam locomotive of the future will probably not be the locomotive of the past. Today we can see possibilities toward further refinement in design and further economies that may be obtained.

For freight service on easy grades where the capacity of the articulated type is not required, we already have exceptionally large locomotives of the six, eight and ten-coupled types. Simple cylinders operating at 200 lb. pressure have reached a diameter of 30 in., and in order to transmit this power a main axle 13 in. in diameter has been used. Main crank pins, connecting rods and other details are of enormous size. With the increase in the diameter of cylinders, the cylinder centers have gradually been increasing, and frame centers decreasing. This has resulted in higher stresses than those caused by piston thrust only. The weight of revolving and reciprocating parts has reached the point now where, in some cases, proper counterbalancing becomes very difficult. It is doubtful whether much more capacity can be obtained in these types if designed along the present lines, and attention could profitably be given to refinement in design and its relation to the careful selection of materials.

The modern passenger locomotive has reached a high state of development, but there is one problem still to be solved that has been recognized for many years, that of the effect on the rail of the vertical unbalanced forces in a two-cylinder engine. At present, our largest and most powerful passenger locomotives have two simple cylinders, 27 in. to 29 in. in diameter, giving maximum piston thrusts of approximately 117,000 lb., with static wheel loads higher than ever before and, with few exceptions, reciprocating parts of much greater weight. The four-cylinder balanced compound was introduced about ten years ago as a possible solution, and for a few years large numbers of these locomotives were built. There is no doubt as to the results obtained, as far as balancing is concerned, but recently very few have been constructed. Four-cylinder simple locomotives have also been tried out, but in both of these types the capacity is limited on account of the available space between the frames, making it practically impossible to provide the power now given by the largest simple two-cylinder engines.

Little consideration has been given to the advantages of the three-cylinder arrangement, although a few locomotives of this type are in successful service today. As compared with the four-cylinder engine, either simple or compound, the three-cylinder type offers the possibility of increased power. With one cylinder located between the frames ample room is provided for a properly designed crank axle and main rod which cannot be arranged for in the four-cylinder type beyond a certain limit. As compared with the two-cylinder engine, the advantages are, briefly, a more even turning moment, an ideal counterbalance condition, and the opportunity to furnish maximum power with the minimum destructive effect on the rail. The power obtained in a two-cylinder engine with cylinders 27 in. in diameter and a maximum piston thrust of 117,000 lb. can be obtained in a three-cylinder engine with cylinders 22 in. in diameter and a maximum piston thrust of 78,000 lb. This decrease of 33 per cent in thrust means a corresponding reduction in the individual weights of all of the machinery.

It is true that considerable progress can yet be made in the two-cylinder engine toward reducing the weights of reciprocating parts by the careful selection of materials and proper design. The three-cylinder engine, however, offers advantages possessed by no other arrangement, and it would seem that for high speed passenger service, at least, this type is well worth considering for the future.

G. R. Henderson, Baldwin Locomotive Works.—There is one subject which has not been referred to except by the committee, and that is the question of powdered coal. I think in a few years we will have largely extended its use. Powdered coal will also assist in lengthening the firebox and give a greater amount of evaporative surface in that way. These things must be considered as increasing the length of the locomotive. In increasing the length, fortunately, we can put a heavier engine over the present bridges without having to remodel their construction. By lengthening, I think it is possible to build a locomotive of 250,000 to 300,000 lb. tractive effort.

A Study of Spring Rigging Design

Discusses the Probable Causes of Failure and Gives Suggestions for Designs to Overcome Them

BY J. P. SHAMBERGER

A prominent road in the middle west has been having trouble with failures of the spring rigging on large power. The most trouble has been experienced on Mikado locomotives, having a weight on drivers of 238,200 lb., and a weight on the leading and trailing trucks of 29,000 lb. and 52,000 lb., respectively. These engines have a tractive effort of 57,000 lb. The arrangement of the spring rigging is shown in Fig. 1. The chief trouble has been experienced with the spring hangers breaking in the fillet at the upper bosses. A study of the design was made with a view of determining the reason why these hangers should fail in this way.

Evidence that the hangers do not fail by direct tensile strain was obtained when comparing the stresses in the equalizers and the hangers. The section of one of the intermediate equalizers 8 in. back from the pin hole is 2 in. by 6 in., and it is loaded to a stress of about 8,000 lb. per sq. in, while the stress on the hanger, which transmits the load to the equalizer, is only 2,740 lb. per sq. in., which would indicate that the equalizer should fail first. Hangers which have worn 20 per cent below size on account of

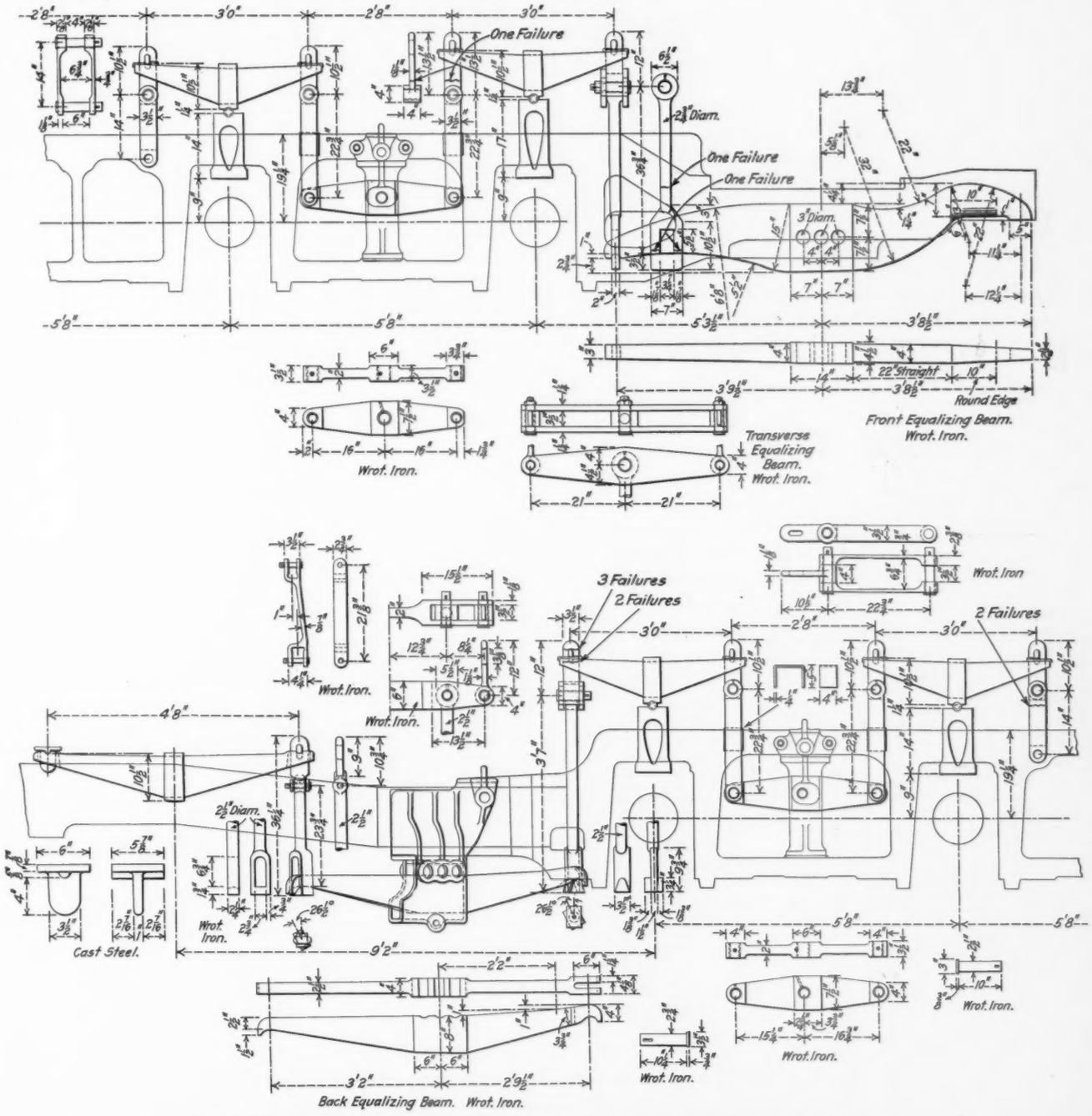


Fig. 1—Mikado Type Locomotive Spring Rigging That Has Given Trouble from Failures

rubbing on the frame have also shown indications of falling at the fillets at the upper boss. From the engine failure reports and from an inspection of the hangers taken from a roundhouse scrap pile, it has been found that all hangers have broken close to the boss; that hangers with bosses of different lengths have broken at the end of the longer boss, and all hangers not completely broken off show a bending at the cracked section, the crack be-

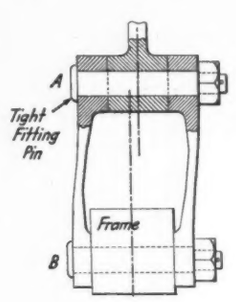


Fig. 2

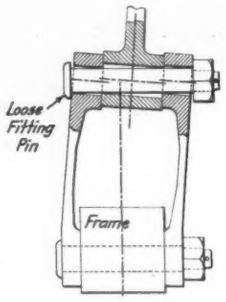


Fig. 3

Bending of Spring Hangers Due to Side Motion of the Rigging

ginning on the inside of the hanger. This would seem to clearly indicate that the hangers are broken by bending, as the failures occur at the section having the largest bending moment. In comparing these hangers with those of other engines of approximately the same weight, and whose spring rigging is of the same design and material, it was found that the hangers on the Mikado locomotives had a longer boss. Since the other engines have not

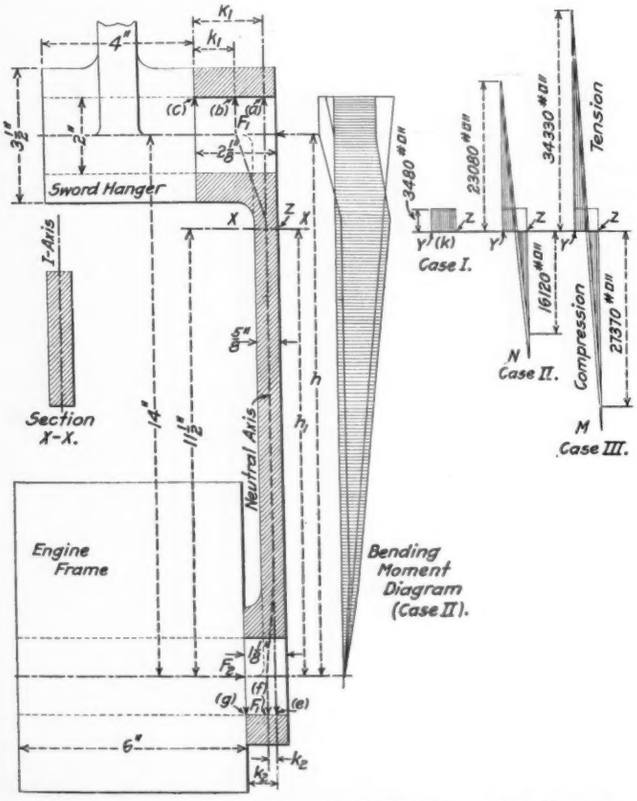


Fig. 4—Diagram of Stresses in Middle Connection Hanger

had this same trouble, it seems right to assume that the long boss is responsible for the failure.

A condition which may produce large bending stresses in a hanger is the sidewise motion of the rigging. This motion is caused by the moving of the driving box upon which the spring saddle rests, or by the elevation of one driver above its mate, relative to the frame. Fig. 2 shows the probable manner of bending when the pin is a tight fit. The bending here is similar to the bending of a beam fixed at both ends. Fig. 3 shows the probable manner of bending when the pin is a loose fit. The action here is similar to that of a beam fixed at one end and loaded at the other. In Fig. 3 the bending moment from the side motion is opposed to the bending moment due to the eccentric loading. It is plain that the hangers do not fail from this side bending, because this is greatest at the frame, whereas the hangers fail at the upper boss. The effect of this side motion is to produce an eccentric loading, the moment from which is a maximum at the upper boss, the point where the failures occur. The same reasoning applies to the hangers whose lower ends are fastened to the equalizer.

Conditions which will give rise to bending moments great enough to produce stresses far above the material's elastic limit

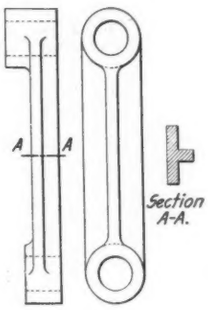


Fig. 5

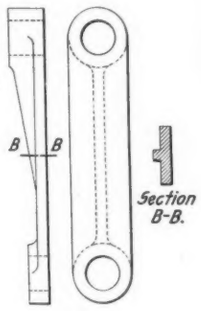


Fig. 6

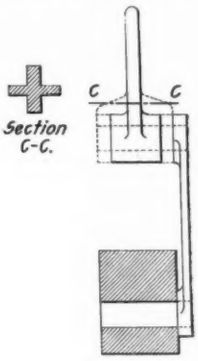


Fig. 7

Designs of Hangers to Resist Bending

are, when the center line of the pin is inclined to the center line of the hole; when the pin fit in the hanger is tapered; when the pin is bent and when the hole in the hanger is tapered. The stress in the body of a spring hanger is the resultant of a direct tensile stress and of a stress due to bending. The bending occurs whenever the reactive forces at the top and bottom bosses have lines of action displaced from the neutral axis of the hanger.

The middle connection hanger which fastens to the frame is the one whose stresses will be determined here. This hanger is shown in Fig. 4, the component bending moments being taken from forces taken *below* the section. Distances to the right of the vertical axis represent counter-clockwise, and to the left clockwise, moments. Three conditions will be considered.

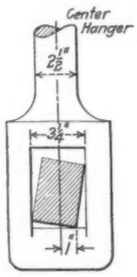


Fig. 8

Fig. 9

Front Center Hanger Under Eccentric Loading

Case I.—The lines of action will be considered as passing through the neutral axis of that part of the hanger exclusive of the bosses. This represents the most favorable condition.

Case II.—The lines of action will be considered as passing through the middle points of the two bosses.

Case III.—This case represents the most unfavorable conditions—lines of action on the inside edges of the bosses.

The reactive forces as shown in Fig. 4 are equal and are designated by F_1 at both top and bottom. In cases II and III these forces form a couple. Since the algebraic sum of the horizontal forces must be zero, the forces of the opposing couple are equal, so they are designated by F_2 at both top and bottom.

Value of F_2.—For case I, F_2 equals zero. For cases II and III, by equating opposing couples we have,

$F_2 h = F_1 k$, where h and k are moment arms.

$$\text{Therefore, } F_2 = F_1 \frac{k}{h} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (A)$$

The bending moment at any section distant h_1, from the center line of the lower pin hole is:

$$M = F_1 k_2 + F_2 h_1$$

Substituting the value of F_2 from (A)

$$M = F_1 k_2 + F_1 \frac{k h_1}{h} = F_1 \left(k_2 + \frac{k h_1}{h}\right) \quad \ldots\ldots\ldots\ldots\ldots (B)$$

CASE I

Value of F_1.—The force transmitted to each spring hanger equals the weight per driver minus the weight of the wheel including the weight of the side rods, one-half the weight of the axle, the weight of the box, the weight of the saddle and the weight of the spring, the remainder to be divided by the number of hangers per spring. In the present case this force is 6,000 lb. or 2,740 lb. per sq. in. The distribution of stress at section XX, Fig. 4, is shown at K.

CASE II

For this case there is a tensile stress and a stress due to bending:

$$\text{The bending moment} = F_1\left(k_2 + \frac{k h_1}{h}\right)$$

Substituting: $F_1 = 6{,}000$ $\quad k_2 = 0.25$ in.
$h_1 = 11.5$ in. $\quad k_1 = 0.75$ in.
$h = 14$ in. $\quad k = k_1 - k_2 = 0.5$

$$M = 6{,}000\left(0.25 + \frac{0.5 \times 11.5}{14}\right) = 3{,}530 \text{ in. lb.}$$

Since the section is symmetrical about its I-axis, the section modulus in tension will be the same as that for compression:

$Z = 1/6\ bd^2$ $\quad b = 3.5$ in. $\quad d = .625$ in.

$$Z = \frac{3.5 \times .625^2}{6} = .228$$

Let S_{bc} = compressive stress due to bending
S_{bt} = tensile stress due to bending

$$\text{Then } S_{bc} \text{ and } S_{bt} = \frac{M}{Z} = \frac{3{,}530}{.228} = 15{,}500 \text{ lb. per sq. in.}$$

As in Case I, the direct tensile stress = 2,740 lb. per sq. in.
The resultant stresses are:
Tensile = 15,500 + 2,740 = 18,240 lb. per sq. in.
Compressive = 15,500 — 2,740 = 12,760 lb. per sq. in.

The distribution of stresses at section XX for this case is shown at N, Fig. 4.

CASE III

For Case III we have:

$F_1 = 6{,}000$ lb. $\quad k_1 = 1.8125$ in.
$h_1 = 11.5$ in. $\quad k_2 = 0.8125$ in.
$h = 14$ in.

Substituting in (B) and solving:

$M = 5{,}560$ inch-pounds, bending moment,

$$\text{and } S_{bc} \text{ and } S_{bt} = \frac{5{,}560}{0.228} = 24{,}400 \text{ lb. per sq. in.}$$

Resultant tensile stress = 24,400 + 2,740 = 27,140 lb. per sq. in.
Resultant compressive stress = 24,400 — 2,740 = 21,660 lb. per sq. in.

The distribution of stresses for this case is shown at M, Fig. 4.

On hangers having a narrow boss, the bending moment may be neglected when a generous factor of safety is used. But with a wide boss the usual factor of safety is not great enough to provide for the stress not considered in the design. The length of the boss on the Mikados is 2⅛ in.; this is ⅜ in. greater than on the next size below. It seems improbable that these hangers should fail by direct tension, as case I gives a factor of safety in tension of about 12. An increase in hanger stress means an increase in driving box reaction and an increase in reaction between the driving wheel and rail. Any force on a driver great enough to break a spring hanger would also break a rail if applied between the ties.

Two general methods suggest themselves for overcoming the difficulty: First, design the hanger so that it will be able to resist the bending moment, as shown in Figs. 5 and 6; and second, use a construction which will practically eliminate the bending moment, and still design the hanger for tension, as in Fig. 7.

The usual construction brings a bending moment on both the sword and the long hanger. They should both, therefore, be made to withstand bending. In Fig. 7 practically all the bending comes on the sword hanger which is made to resist it, while the long hanger is subjected to tension and is designed accordingly.

Fig. 8 shows how an eccentric loading may be brought on the front center hanger by an inclination of the hanger or equalizer.

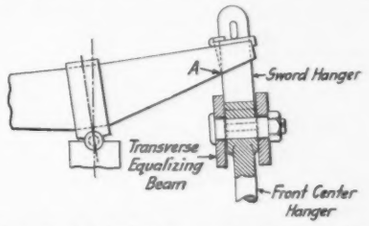


Fig. 10—Showing Restricted Movement of Sword Hanger in Spring

The vertical load on this hanger is 24,000 lb. If the load is supported 1 in. from the center the bending moment will be:

$$24{,}000 \text{ lb.} \times 1 \text{ in.} = 24{,}000 \text{ in. lb.}$$

$$Z = \frac{\pi D^3}{32} = \frac{\pi \times 2.5^3}{32} = 1.4$$

$$p = \frac{M}{Z} = \frac{24{,}000}{1.4} = 17{,}000 \text{ lb. per sq. in.}$$

The tensile stress will be increased by the direct tension, which is:

$$\text{Area of hanger} = \frac{\pi D^2}{4} = \frac{\pi \times 2.5^2}{4} = 4.9 \text{ sq. in.}$$

$$\frac{24{,}000}{4.9} = 4{,}800 \text{ lb. per sq. in.}$$

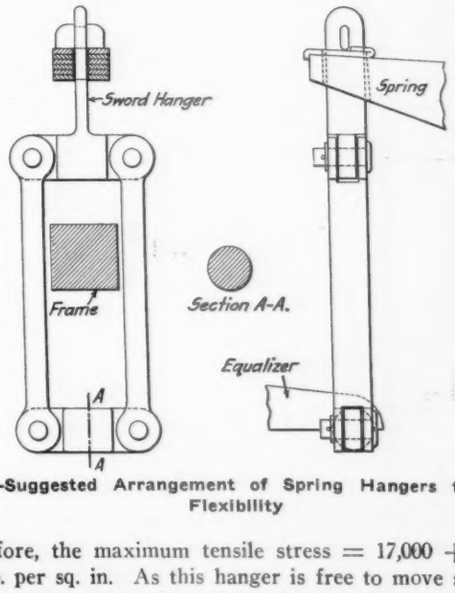


Fig. 11—Suggested Arrangement of Spring Hangers to Provide Flexibility

Therefore, the maximum tensile stress = 17,000 + 4,800 = 21,800 lb. per sq. in. As this hanger is free to move sidewise it would probably assume the position shown in Fig. 9 under an eccentric loading. That is, the hanger would swing until the line of action of the loading would pass through the center of the upper supporting pin. The bending moment would then be greatest at the bottom. An inspection of the front equalizing beams on the Mikado engines shows a great many of them apparently inclined. But if there is an even bearing of the center hanger on the beam for some particular position of the rigging, any side movement must necessarily produce an eccentric loading.

Fig. 10 shows how a restricted movement of the sword hangers in the spring will cause eccentric loading on the front center hanger. Under a large vertical movement of the spring the sword hanger will strike at the point A. This brings a bending moment on the hanger, but the force producing it is compara-

tively small and the hanger is strong against bending in this direction as its section is deep. Its serious effect is to prevent the pin from alining itself with the front center hanger, and in forcing the front transverse beam forward, while the center hanger tends to force the other transverse beam backward. Inspection of these hangers shows indentations, indicating that they have borne against the spring. The wearing of the holes into an oblong shape is probably due to the high bearing stress.

The short hangers which fasten to the frame have a boss 1⅛ in. long, with a hole 2 in. in diameter, giving a projected area of 2¼ sq. in. As each hanger bears 6,000 lb., the unit pressure will be:

$$\frac{6{,}000}{2.25} = 2{,}700 \text{ lb. per sq. in. of projected area.}$$

This stress is great enough to actually crush the metal outward, and as these bearings are practically free from lubrication, very slight movements will produce rapid wear.

Fig. 11 shows an arrangement which might be used to advantage. Here the hanger pins are placed lengthwise with the frame instead of across it. This will permit the hangers to adjust themselves to the side motion of the rigging without subjecting themselves to bending or to eccentric loading. In this arrangement the movement of all the members is such as to eventually wear for themselves the longest possible bearing. This is in contrast to the present rigging, where the spring hanger cannot have a bearing along the entire length of its boss except in one position of the rigging. The side movement of the present rigging does not tend to wear the broadest possible bearing for the boss.

The lack of what might be termed "transverse flexibility" in the present spring rigging is probably its greatest defect. There is no question about the side movement of the hangers. The excessive wear on the frame shows this. Furthermore the side motion of the drivers and the elevation of one above the other is considered in the design of the driving boxes. The spring saddle rests upon the driving box and the spring upon the saddle, so that any movement of the box must be transmitted to the spring. The box is designed for tilting, but the spring rigging for no side motion. This seems inconsistent. There is a certain amount

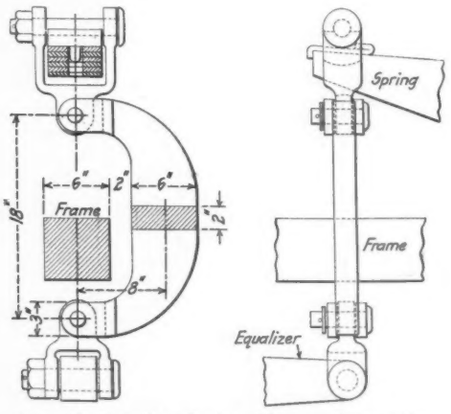


Fig. 12—Another Spring Hanger Suggestion

of play at the hanger pins, but this will produce a bending moment which the hanger is not designed to resist.

One end to be sought in designing a spring hanger is to make one which will last the life of the locomotive. This is utterly impossible at present. Even were a hanger made which would not be bent by side motion as in Fig. 11, or which would resist an eccentric loading, its life would be limited by wear on the frame or on the frame protectors, when in place. Frame wear cannot at present be avoided because of the small clearance between the frame and the drivers. The defects of the present arrangement may be summed up as follows: Poor oiling facilities; frame wear cannot be avoided because of the small clearance between the frame and the inside of the driver; non-flexibility in a transverse direction, except at the expense of bending the hanger directly and by eccentric loading; side motion of the rigging will not tend to wear flat bearing surfaces, and the life of the hanger is limited by wear on the frame.

In the arrangement shown in Fig. 12 the present tension arrangement is abandoned and a single member is placed on the inside of the frame, being subjected to direct tension and bending. The pins are placed lengthwise with the frame to permit side movement. The wear of the members in Fig. 12 is such as

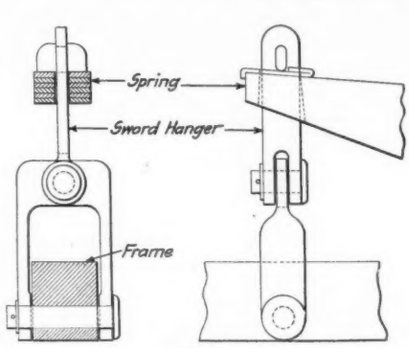


Fig. 13

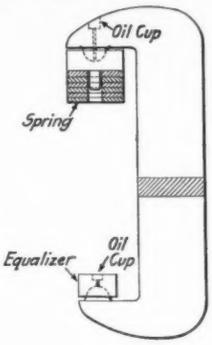


Fig. 14

Suggested Designs for Short Hangers

to eventually give a bearing as long as the boss. As the hanger is placed inside of the frame, the clearance between itself and the frame can be made large enough to avoid wear. The stress in such a hanger would be:

$$12{,}000 \times 8 = 96{,}000 \text{ in. lb. bending moment}$$

$$\text{Section modulus} = \frac{2 \times 6^2}{6} = 12$$

$$p = \frac{M}{Z} = \frac{96{,}000}{12} = 8{,}000 \text{ lb. per sq. in. from bending}$$

$$\frac{12{,}000}{2 \times 6} = 1{,}000 \text{ lb. per sq in. in direct tension}$$

$$8{,}000 + 1{,}000 = 9{,}000 \text{ lb. per sq. in. maximum tension}$$

If an I-section were used in Fig. 12, a larger section modulus could be obtained, giving a lower stress for the same section area.

Fig. 13 shows an arrangement which would give transverse flexibility to the short hangers when using the usual sword hanger. A ball bearing should be used on the front equalizing beam, and the sword hangers connected to the transverse equalizing beam should have freedom of movement. Fig. 14 shows an arrangement for using a ball bearing at the spring and at the equalizer. The possible objections to this would be: Liability to unseat; liability to turn and be subjected to bending in a direction in which it is weak; high bearing stress; great weight, and that it does not hold the spring on its seat by restricting its side motion.

However, the ball bearing arrangement would no doubt be as firm on its seat as is the spring on its pin. It could be prevented from turning by a forked member thrown loosely over opposite hangers. The bearings could be removable, and made of specially hardened material so as to stand a high bearing stress. The weight should be no objection if they did not fail and need to be replaced in roundhouses.

The advantages of the arrangement shown in Fig. 14 are: Good oiling facilities; simplicity; will eliminate wear of itself or the frame by proper selection of clearance; ideal flexibility without subjecting itself to bending or eccentric loading; stresses can be accurately computed, and as a result of the previous advantage there should be no engine failures from broken hangers.

Possibly the greatest objection to a single hanger used to connect the spring with the equalizer is its weight, but this objection should disappear if it will eliminate hanger failures and wear on the frame. An inspection shows that the frame is worn because only about one-half of the frame protectors are in place. The others are either torn loose from the frame or else have the side broken off. But heavy as it must be, it would harmonize with the design of a heavy locomotive.

CAR DEPARTMENT

LUBRICATION OF CAR JOURNALS*

BY W. A. CLARK
General Car Foreman, Duluth, Missabe & Northern, Proctor, Minn.

The lubrication of car journals should be investigated systematically, the results summarized and used as a guide in practice. The bearing surfaces of both the journals and brasses must be smooth and true, the brasses being large enough and of sufficient strength to resist spreading or closing, when they are subjected to the maximum pressure of the service in which they are used. The wedges should be of correct dimensions. If they are too large, having a crown bearing only, the load will be concentrated, causing excessive friction which, in turn, will cause the rapid heating of the brass and journal. Under high capacity cars, wedges with only a side bearing will cramp the brass to the side of the journal and cause excessive heating.

Oil boxes are a factor in lubrication. There are a variety of designs, shapes and sizes. Different results are obtained from the extremes in either case. Some boxes are very narrow, making it difficult to place or keep the sponging in its proper position. There are other boxes considerably larger that allow the sponging to become disarranged to such an extent that it soon works away from the journal. Then, again, there are boxes in which, when properly packed, the sponging will have very little movement.

When excessive journal friction develops, trouble manifests itself when the temperature rises more rapidly than it can be dissipated by the metals in the box. This causes the oil to volatilize, preventing it from reaching the parts under pressure. This increases the friction, thus increasing the heat until the brass breaks or melts. With the journal bearing surface destroyed the heat will increase until the journal is burned off or broken. The trucks should be square and true, otherwise the brasses may be forced against the box or fillets, or against or on top of the collars. The box may be out of line with the result that heating will occur in proportion to the freedom that the brass has, or the amount that the truck is distorted.

There are a number of causes with a combination of conditions other than a lack of oil that will produce hot boxes. One of the principal causes is the moving of the sponging or packing away from the journal. The lateral movement of the axle forces the packing away from the inside or fillet end of the journal. It must follow that a surface in contact, under pressure and revolving, will generate heat at the point where the packing and oil do not touch the journal. This heat is conducted to the full length of the bearing and in time causes a hot box. This is a difficult condition to detect from an outside examination of the box. It can be corrected by using the packing spoon to replace the packing in the back end of the box and in contact with the full length of the journal.

The oil box as used on railway equipment cannot be even one-quarter filled with oil as the hole in the back of the box is about 1½ in. from the bottom. This should show the necessity of having a good grade of saturated waste placed and kept in the proper position in the oil box. It should be a practice when examining boxes, or when they show signs of heating, to use a packing spoon to put the sponging back in contact with the journal. The most important element in the lubrication of car brasses is that the oil be conveyed to every part of the journal.

Axles and journals as now made from steel give little trouble. The percentage of hot boxes originating from journal defects is small. The brass or bearing has a direct influence on the manner in which a journal will run. Every precaution should be taken to procure a perfect fit with a grade of bearing metal suitable to withstand severe service. In following up and investigating hot box reports a number of brasses that caused trouble were examined. In nearly every case the lining had worn away at the center and not at the ends of the brass, due to a variation in the structure. On breaking the brasses longitudinally for examination they were found to consist at the center of a mixture different from that at the ends. Others were found that were not solid, or had longitudinal fissures or flaws. The difference in the rigidity of the metal produced an unequal distribution of the pressure. The question of foundry practice, or the care exercised in manufacturing car brasses, is one of the most important features in furthering perfect lubrication. Dross or sand when mixed with the bearing metal causes unequal hardness, or what are termed "hard spots." As the soft metal wears away, concentrating the pressure on the hard spots, excessive friction will be caused, producing a rapid rise in temperature and ultimately a hot box. The only remedy for this trouble is to change the brass. It would seem proper to use a high grade of metal for the lining of car brasses. A more general investigation of this subject would undoubtedly be the means of showing the importance of the proper mixtures for journal bearings in heavy capacity car service.

The linings in use on the European railways are made from copper, tin and antimony, and may be considered as having tin as a base. The general American practice is to use lead and antimony or lead, antimony and tin or a lining with lead as a base. A dynamometer car test of from 65 to 80 cars with bearings with lead linings, as against tests of cars with bearings made from babbitt, or of copper, tin and antimony, or copper, tin, antimony and lead, would probably show some surprising results in an increase or decrease in journal friction, abrasion and fuel, thus showing the advantage of a tough homogeneous anti-friction car brass lining. It is my opinion that a field is open for investigation in the matter of the comparative wearing and frictional qualities of different mixtures of metal. With a 70-car train we have 560 car journals. With a small decrease or increase of friction per journal, a noticeable loss or saving on brasses, journals and fuel would be effected. There is one point that would have to be considered in a test as suggested, and that is, that the trains be equipped with anti-friction side bearings of the same pattern in order that flange friction may not be confused with journal friction.

The road track conditions, or even yard tracks with high or low joints affect the condition of the packing. There will be fewer hot boxes on cars moved over good tracks than on those that travel over rails not in as good alinement. The handling of cars also has an effect on the trucks and inasmuch as the brass is affected by every movement of the truck, it must follow that all shocks are transmitted to the brass.

Trouble will also occur when the packing has become ground up and reduced to a pulp, or when the strands have become so short that proper capillary action cannot take place to convey the oil from the bottom of the box to the journal. When boxes are packed too tight so as to shut off the flow of oil it causes a wiping action instead of lubricating the journal. When the packing is too loose it falls away and settles down below the journal. Also, when the packing has become glazed from dirt the flow of oil to the journal is retarded, or when the packing has too large a percentage of oil it becomes heavy and soon settles away from the journal.

After hot box compound that has been used on a hot journal becomes cool it will make the packing a hard, solid mass like

*From a paper presented before the Missabe Railway Club, Proctor, Minn., November 30, 1914.

grease, shutting off the flow of oil from the bottom of the box. Packing in this condition invariably causes trouble if it is not removed at destination. Hot box compound is intended to be used only when journals show signs of heating beyond the point where car oil will not lubricate (a certain temperature, about 300 deg. F., at which car oil vaporizes or passes off in the form of a gas or smoke). It is made from mixtures that do not volatilize at as low a temperature as car oil. However, on account of its damaging effect on the packing after the journal has become cooled, it should be used sparingly and only on journals that car oil will not lubricate.

Many train delays would be avoided if prompt attention could be given to journal boxes when they first show signs of heating, thus saving broken brasses, cut journals and the setting out and picking up of cars. Delays and hot boxes can be reduced to a minimum by all concerned giving attention to the details, particularly to the condition of the packing. The oil boxes on this road are being systematically repacked. The waste and oil removed is cleaned, special attention being given to retaining the oil in the box. The packing is in better condition and more oil is in the boxes than at any time heretofore.

In view of the possibility of a box or boxes having some or all of the packing removed, a brass or wedge cracked or broken, and the large number of other causes that bring on the heating of journals, it would seem that, from an operating and safety standpoint, no train should be allowed to run very many miles from its starting point until the crew are given an opportunity to satisfy themselves that all the journals are running cool.

The suggestions as outlined are intended to bring to the notice of those who may be interested in this subject the fact that the lubrication of modern railway cars is worthy of more than a passing interest if a reduction of train resistance is desirable.

NO "GREATEST DEFECT" IN BOX CARS*

BY CHARLES E. WOOD
Foreman Freight Repairs, Union Pacific, Armstrong, Kan.

What is the greatest defect in box cars and how can it best be remedied? The answer depends entirely on the point of view. The train and engine men, if asked, would without any hesitation refer to our old friend, the draft gear problem; the claim department would say leaky roofs; the freight house men and those having to do with loading and unloading would swear by and at the side doors which will not open or close; while the air brake inspector thinks he has all the trouble in his effort to maintain his 85 per cent of efficient brakes. Each branch has its own particular complaint to register, but when we get to the car repair foreman, who gets the cars in the shop for each and every ill that the box car is heir to, he is at a loss to place his finger on any defect and say it is the greatest.

During the past few years great strides have been made in freight car construction, and as each succeeding sample car comes to us, we look it over and try and locate the weak spots and say, "At last we have the car that will stand; it is hard to see wherein it could be improved." But after a few months service we find a faulty piece of designing and consequent trouble developing at a point where we least expected it.

It was suggested in the announcement of the competition by the *Railway Age Gazette, Mechanical Edition,* that the draft gear question be left out, and it has been very thoroughly covered in recent issues. I would just state in passing, however, that the champions of the friction gear are not found among the freight repair men. H. C. Priebe, in the September issue, page 453, voices, I believe, the sentiments of 75 per cent of the car foremen of this country.

I believe that next to the draft rigging the roof is the greatest source of trouble. Designs which were thoroughly satisfactory 15 years ago are now worthless and do not last over a year or so. We will have to get away from the combined wood and metal roof and develop the all-metal roof until we have brought it to the required state of perfection. There are a number of good all-metal roofs now being tried out, and after a little more experience with them we should have a roof which will be thoroughly satisfactory.

Unfortunately, the side door and its stubborness is a feature on which we do not appear to be making much progress. It is true, we have more elaborate and costly fixtures than we had in the old days, but it is also true that we have more trouble with the side doors than we did then. It is admitted that the size of the doors has increased considerably, thus making the designing of efficient hangers a much more difficult matter; but the fact remains that in spite of all the inventive genius which has been brought to bear on this subject, we are far from having a satisfactory door on our box cars. If anyone doubts this statement, he has, in order to be convinced, only to go into any freight yard and try to open a few doors unaided. It would appear that we will have to sacrifice the most desirable feature of having a water tight and dust proof door to providing one which can be operated without the use of pinch bars, relying upon temporary stripping for protection when the contents are of such a nature that this action is necessary.

The air brake is now in such a highly perfected condition that it would appear almost sacrilegious to offer any criticisms upon this, but so much of its efficiency depends upon proper maintenance that it is imperative that it should receive our best attention. The regular and systematic draining of main reservoirs will go a long way toward keeping the triple valves in better condition. "Water in triple valve" is too often the cause of defective and inoperative brakes. Piston packing leathers, too, should be renewed as soon as defective; they are too often overlooked and investigation will show that fully 50 per cent of our defective brakes are due to packing leathers being worn out.

The end construction of box cars in general has left a great deal to be desired. Broken end posts, ends bulged out, etc., are prolific causes of bad order cars. A great many remedies have been tried out; end posts have been reinforced with iron plates; end truss rods have been applied, but the shifting load was irresistible and all our best designs went down to defeat. But the advent of the all-steel end bids fair to overcome this difficulty, and the increased first cost will be more than justified in the saving on repairs.

The improvements in truck designs have kept pace with the car body. The arch bar truck has had a long reign, and cracked arch bars have caused many a bad derailment. The maintenance of nuts on column and journal box bolts has always been difficult, but very necessary from a safety standpoint, and their elimination by the solid cast steel truck sides, which are now in general use on new cars, has lifted a heavy burden from the car inspectors and foremen.

In conclusion, the many improvements being made show that the car department is not behind the locomotive department in its effort to keep pace with modern requirements, but is always on the alert to overcome the weak spots, and if each railroad will do its share of ridding our rails of the light wooden underframe cars, and also reinforce the earlier steel underframe cars, some of which are proving to be entirely too light, it will become increasingly difficult for anyone to pick out the greatest defect.

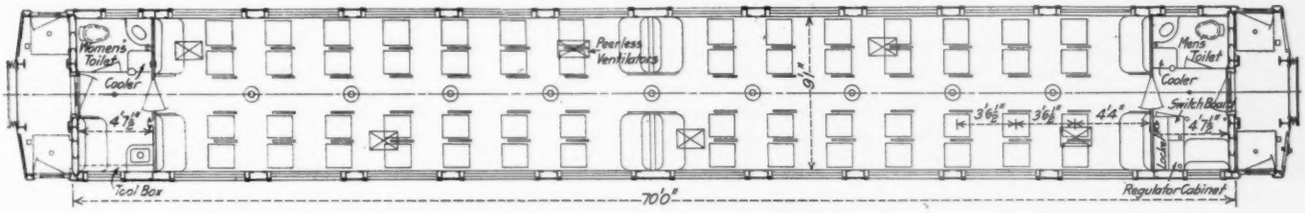
*Entered in the car department competition which closed October 15, 1914.

THE DIAMOND IN STEEL BORING.—In extending the use of the diamond to boring hardened steel it was found that the diamond seems to act equally well at almost any ordinary boring speed, as long as the depth of cut is not sufficient to catch the cutting edge and spring the bar. The speeds and feeds seem to be about the same as in using a steel tool on soft steel, although it is possible that a higher speed might be maintained should it be found desirable.—*American Machinist.*

STEEL COACHES FOR THE SANTA FE

New Passenger Equipment 70 Ft. Long Over End Sills; Day Coach Seats 83 Passengers, Chair Car 76

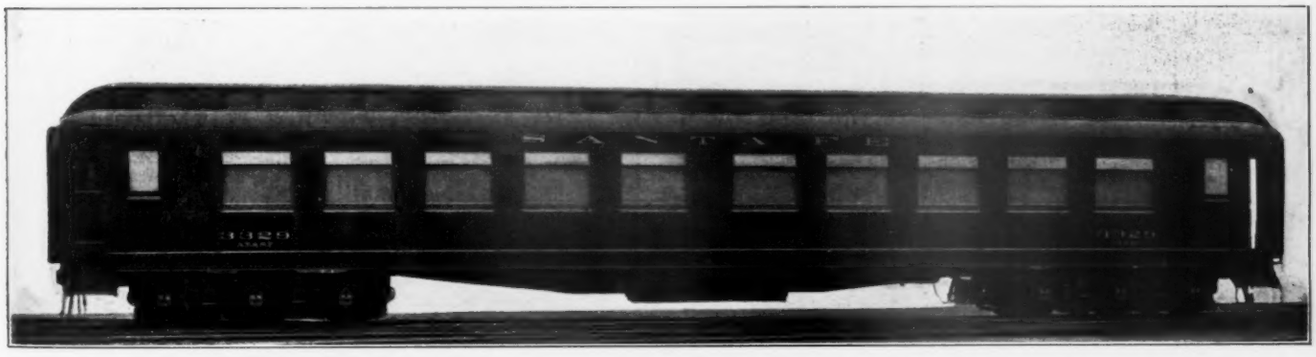
The Atchison, Topeka & Santa Fe has received from the Pullman Company 76 coaches and 49 chair cars of all-steel construction, which were designed in the office of the engineer of car construction of the Santa Fe, and represent distinctly Santa Fe practices. The principal details are practically identical for both types of cars. The interior arrangement is the same, with the exception of the seats and an additional sink opposite the women's saloon in the chair cars, which is provided with hot and cold water and was installed for the convenience of women passengers traveling with children. The coaches will seat 83 passengers and the chair cars 76. The chair cars are used in the transcontinental service. Both types of cars measure 70 ft. over end sills and 77 ft. 8 in. over buffers. The chair cars weigh 13,600 lb. and the coaches 13,400 lb. The inside length is 69 ft. 4 in. and the width is 9 ft. 1 in., the width over side sills being 9 ft. 6 in. The only wood used in the cars is the ⅞-in. pine flooring and the window capping. The exterior is painted the new Pullman standard body color, and the interior is finished in imitation dark mahogany, which is enameled and baked.



Floor Plan of the Santa Fe Steel Chair Car

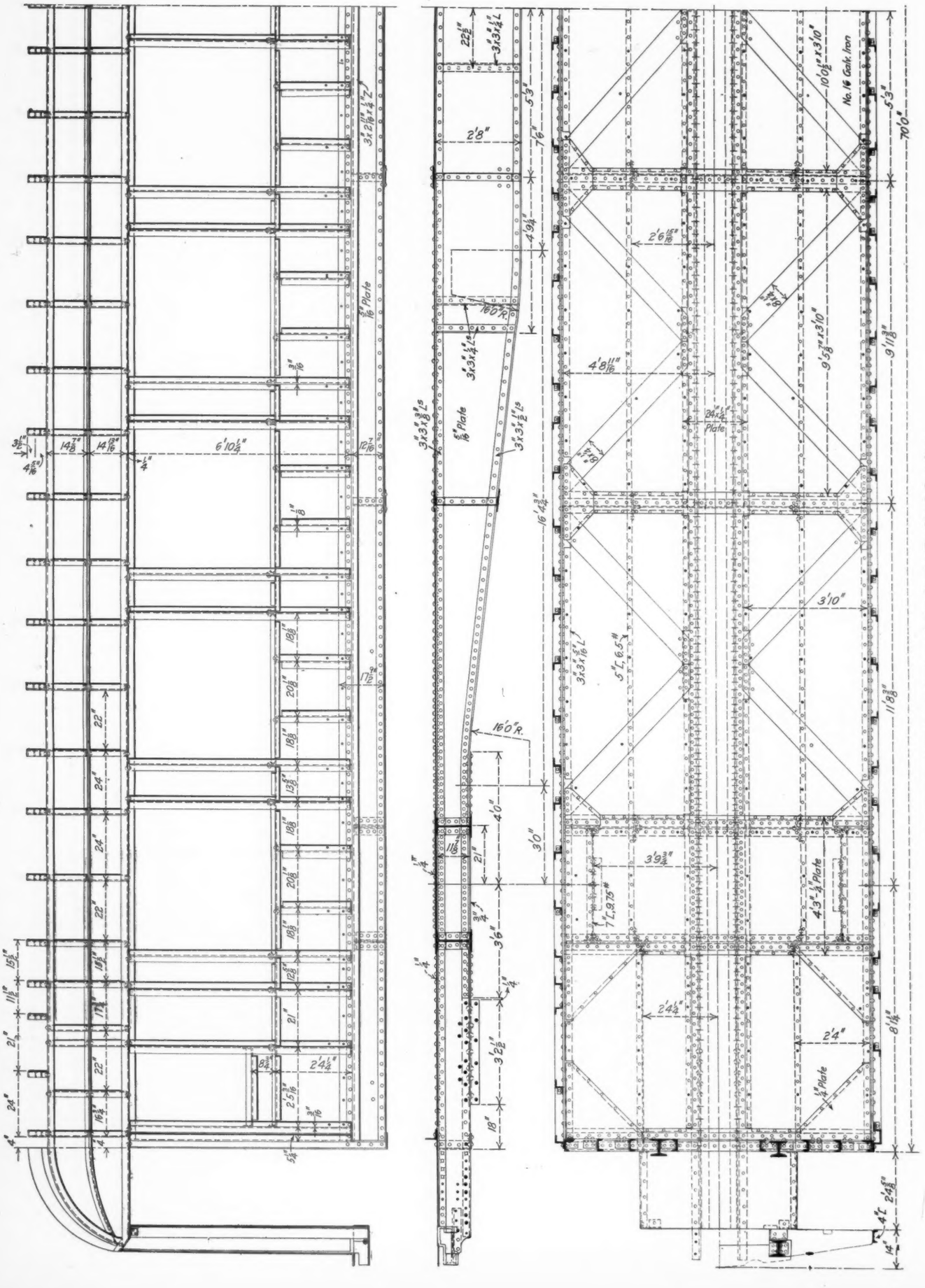
The construction of the underframe is shown in the accompanying drawings. It is made up entirely of structural steel shapes and steel plates. The center sill is of the fish-belly type, being 2 ft. 8 in. deep at the center for 7 ft. 6 in. each side of the middle of the car. These sills then taper for 16 ft. 4¾ in. to a depth of 12⅛ in. at the body bolster. They extend throughout the length of the car between the vestibule end sills. The girders are 14 in. apart and are made up of 5/16-in. plates with two 3-in. by 3-in. by ⅜-in. angles at the top and two 3-in. by 3-in. by ½-in. angles at the bottom. A top cover plate ¼ in. thick and 24 in. wide extends the full length of the car. Two center and two intermediate crossties are located 5 ft. 3 in. and 15 ft. 2⅜ in., respectively, on each side of the middle of the car. They are made up of single ¼-in. pressed steel diaphragms which extend between the webs of the center and side sills; a diaphragm of the same material is placed between the webs of the center sill at these points. The crossties are reinforced by a top and bottom cover plate ¼ in. by 8 in., the top cover plate extending entirely across the car, while the bottom cover plate extends only from the center sill to the side sill on the center crosstie. A pressed steel gusset plate is used in the center crossties, as shown in the illustration, to stiffen the lower connection with the center sill. A triangular ¼-in. gusset plate is used at the junction of the top cover plate and the side sill at each crosstie. This gusset also connects the crossties with the diagonal braces, which are of ¼-in. by 8-in. steel plate. Diagonal braces ¼-in. by 8-in. extend from the side to the center sills.

The double body bolsters are made up of double diaphragms of ¼-in. pressed steel, placed back to back and located 21 in. on each side of the truck center. Similar diaphragms are inserted between the webs of the center sill, as in the case of the crossties. At this point each of the center sill girders is reinforced by a ¾-in. by 6-in. bottom cover plate, extending 4 ft. back and 3 ft. 6 in. forward from the center line of the bolster. The bolsters themselves are strengthened by 7-in., 9.75-lb. channels, located 3 ft. 9¾ in. on each side of the center line of the car. These braces also support the side bearing of the car body, 3-in. by 3-in. by ¼-in. angles 19 in. long, and a bottom cover plate ¼ in. by 6 in. by 15 in. long being applied at the bottom of the channel in the center for this purpose. The body bolsters are further reinforced by a top cover plate of ¼-in. steel 4 ft. 3 in. wide, which extends between the side sills in one piece. A bottom cover plate ½ in. by 8 in. is riveted to each set of diaphragms, and large triangular gusset plates of ¼-in. steel connect the bolster with the side sill at the side nearest the end of the car.



Steel Passenger Equipment for the Atchison, Topeka & Santa Fe

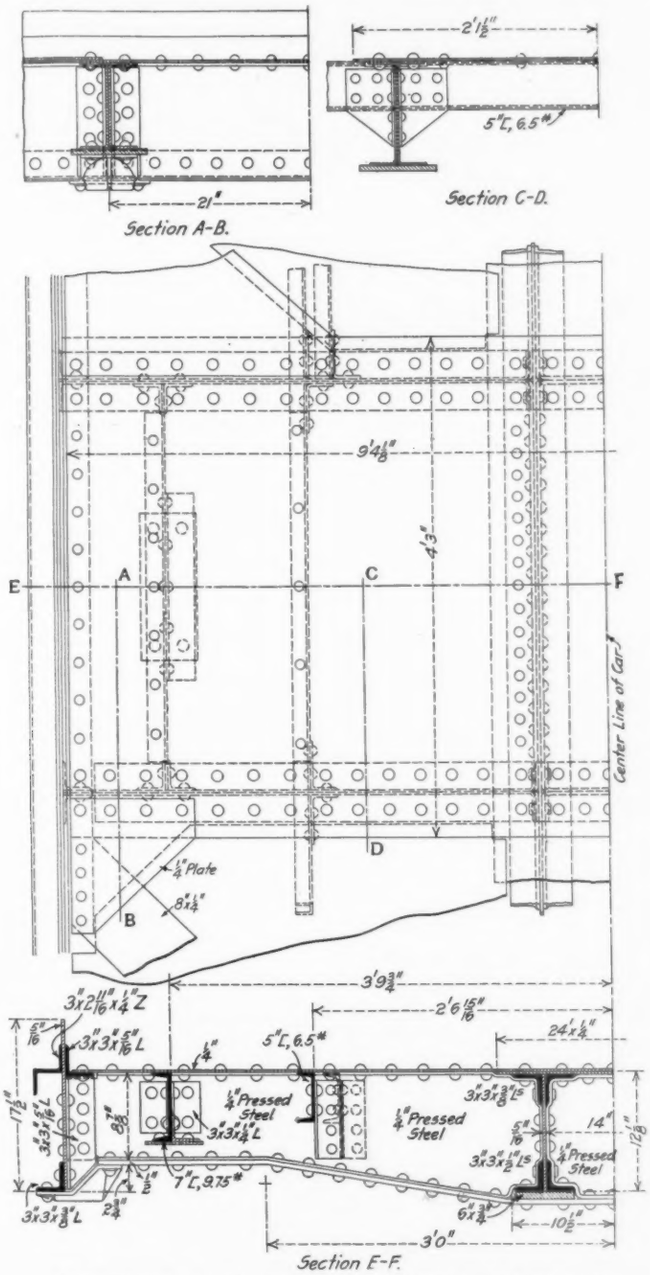
The end sill is made up of a ¼-in. pressed steel diaphragm, extending between the center sill and the side sill. This diaphragm has a 3-in. flange to which is riveted a ⅜-in. by 8-in. top cover plate and a ¼-in. by 6-in. bottom cover plate, the latter extending across the car from side sill to side sill. The top cover plate is reinforced by a 3-in. by 4-in. by ¼-in. angle, located 3¾ in. back from the face of the end sill, and to this



Arrangement of the Framing of the Santa Fe Steel Coaches

are riveted the end posts. Large ¼-in. gusset plates are used to tie the end sill to the side sills. An 8-in., 11.25-lb. channel is located 28¾ in. on either side of the center line of the car and extends between the end sill and platform end sill, which is a steel casting.

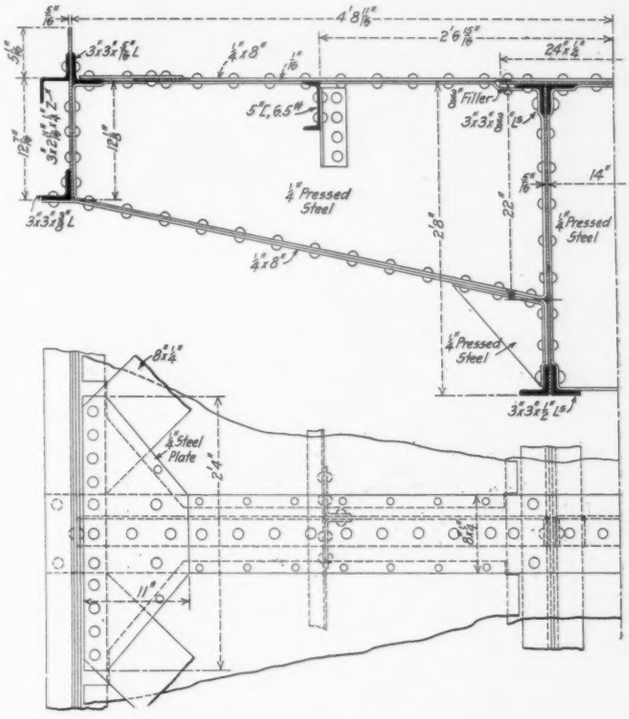
The side sills are made up of a 17¼-in. by 5/16-in. web plate, reinforced at the top by a 3-in. by 2 11/16-in. by ¼-in. Z-bar on the outside and a 3-in. by 3-in. by 5/16-in. angle on the inside, and at the bottom by a 3-in. by 3-in. by ⅜-in. angle on the



Arrangement of Body Bolster on the Santa Fe Steel Cars

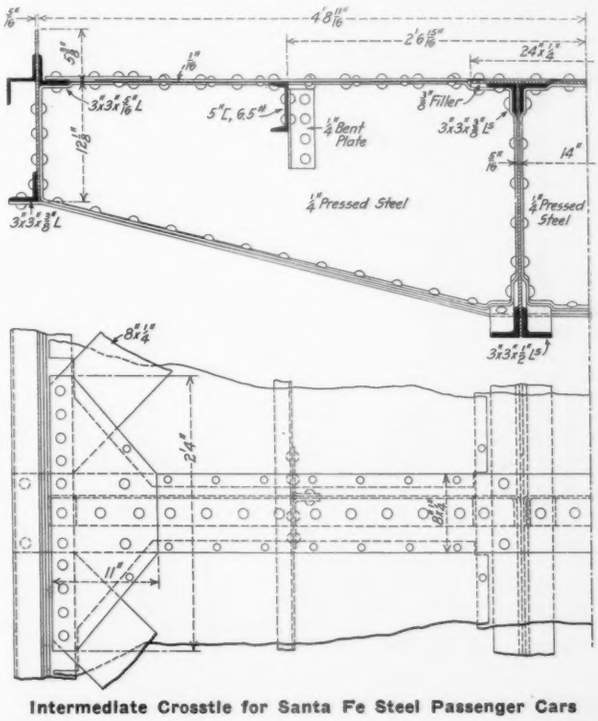
outside. These sills extend between the end sills. The side posts have a Z-shaped cross-section, the through posts being pressed from 3/16-in. steel and the short ones from ⅛-in. steel. The belt rails are ⅛-in. pressed steel of Z-shaped cross-section, the inside and outside sheathing being riveted to the flanges. The side plates are of ¼-in. pressed steel, and also of Z shape, extending through between the vestibule ends.

The end construction is of an anti-telescoping design, two sets of 6-in., 23.9-lb. I-beams being riveted to the end sill, and the platform end sill 22 in. on either side of the center of the car. In addition to these I-beams there are six intermediate end posts made up of 4-in., 5.25-lb. channels. The corner posts are made up of 3-in. by 2 11/16-in. by ¼-in. Z-bars, which are reinforced by 5/16-in. by 2 11/16-in. plates, and ¼-in. pressed steel



Center Crosstie for Santa Fe Steel Passenger Cars

channel-shaped members, with flanges 1¾ in. and 3½ in., a 1¾-in. by 1¼-in. by ⅛-in. angle being riveted to the longer flange. The end posts are secured to the end sill by pressed steel gussets. The end plate consists of a 6-in., 8-lb. channel bent

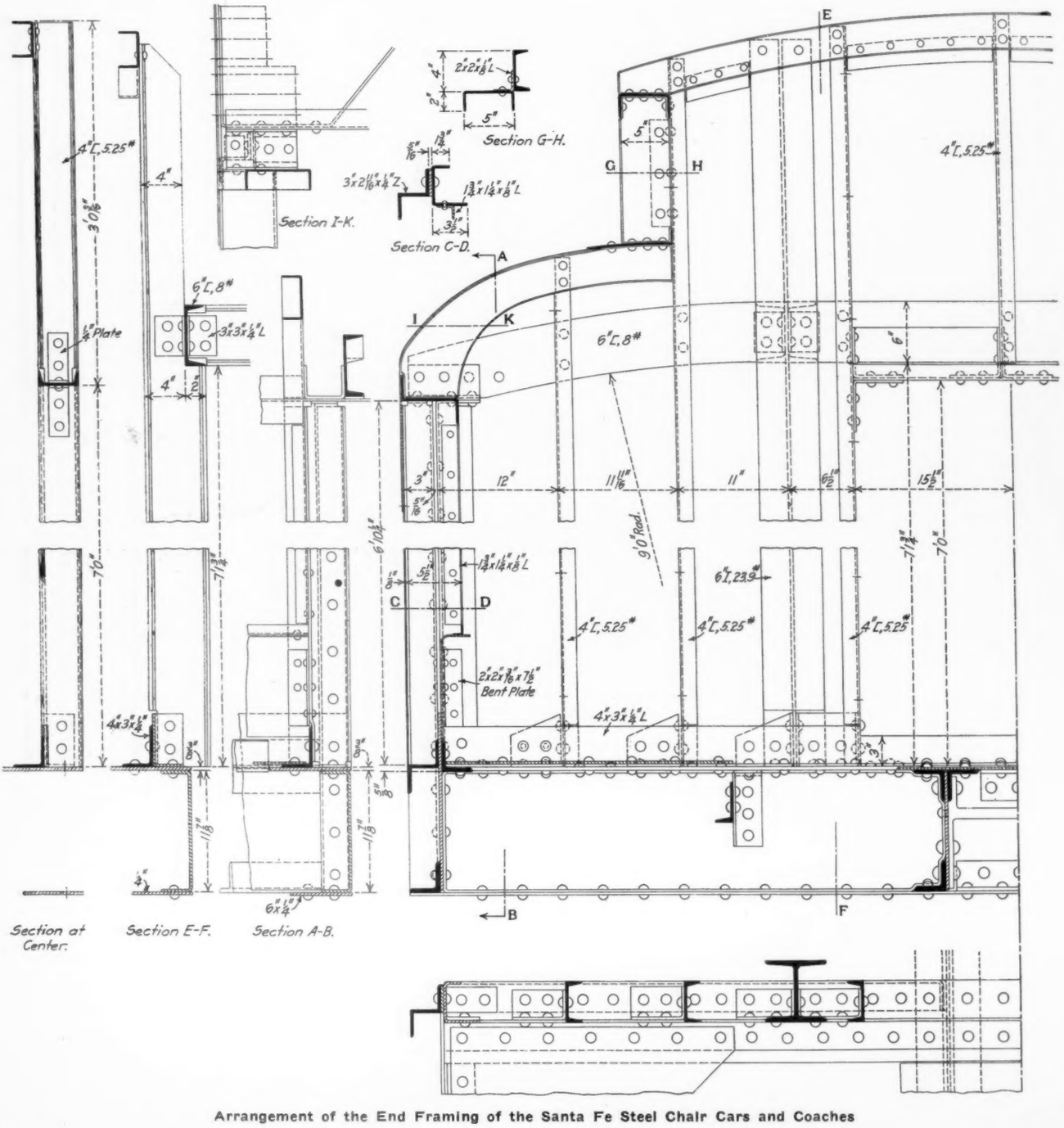


Intermediate Crosstie for Santa Fe Steel Passenger Cars

to a radius of 9 ft. from the side plate to the I-beam end post, then continuing straight across to the other I-beam. The upper and lower deck carlines and the deck posts are pressed in the

shape of a channel from ⅛-in. steel. The deck sill is a 3/16-in. by 1½-in. by 8½-in. pressed steel angle. The deck plate is a 3/16-in. pressed steel channel, with flanges 2¼ in. and a 5-in. web, the sheathing being riveted to the flanges. The side plate is pressed steel and of Z shape.

In addition to the side and center sills, the floor is supported by a 5-in., 6.5-lb. channel, located 2 ft. 15/16 in. each side of the center line of the car. The underframe is entirely covered by lead. Flexolith pieces, covered with No. 14 sheet copper, are applied to the sides and ends of the car, except at the toilet rooms. The insulation between the inside and outside sheathing for a few inches above the side sill consists of four courses of ¾-in. Flaxlinum. The sides, ends and roof of the car are insulated with ¾-in. Flaxlinum, tightly fitted and held in place between the frame members by No. 20 pressed galvanized iron bands, sprung in place and fastened by ¼-in. stove bolts. The frame mem-



Arrangement of the End Framing of the Santa Fe Steel Chair Cars and Coaches

1/16-in. galvanized steel, which is riveted to the underframe members under the diagonal braces and gusset plates. On top of this is placed a layer of ¾-in. fireproof Flaxlinum, fitted in between the nailing strips and secured with cleats with ½-in. fireproof Flaxlinum under them. A 1½-in. air space is left between this insulation and the floor proper, which is built of ⅞-in. by 3¼-in. tongued and groved yellow pine laid in white bers themselves are insulated with ½-in. Flaxlinum, cemented at the edges.

The outside sheathing of the car is ⅛-in. open hearth steel plate, and the inside consists of No. 18 steel plate. The roof sheets of the upper deck are of No. 14 galvanized steel, while those of the lower deck are of No. 16. The roof and hood covering is No. 16 open hearth galvanized steel. The roof sheets

are given one coat of metal roof primer and two coats of metal preserving paint. This is the only part of the exterior of the car that is not sand-blasted before it is painted.

The trucks used on these cars are the Santa Fe standard six-wheel cast steel type, having a 10-ft. 6-in. wheel base and 37¼-in. wheels with 3⅛-in. steel tires. The trucks are provided with Barber rolling center plates and side bearings, Symington journal boxes and L. N., Creco brake beams. Other

Framing of the Santa Fe Steel Passenger Cars

specialties applied to these cars are McCord window fixtures and weather stripping, two North Pole sanitary drinking fountains, Utility ventilators, Gould axle lighting system with Electric Storage Battery Company's batteries, Miner friction tandem draft gear, type A-19 B, and Westinghouse air brakes. Nut locks are applied to all bolts where possible, and where this is not possible the bolts are riveted over. The Chicago Car Heating Company's system of steam heat is used, and as a special feature, two risers of 1¼-in. pipe 16¼ in. long extend up inside the panels, between the windows, from the longitudinal heating pipe. Holes are made in the belt rail, and openings left in the top and bottom of the car to provide a circulation of air at these points.

ERIE CABOOSE WITH STEEL CENTER SILLS

There have recently been placed in service on the Erie a number of cabooses with wooden superstructure and six wooden longitudinal sills, but equipped with steel center sills, body bolsters and end sills. These cars are 28 ft. 6 in. long over body end sills, but the center sills extend through between the striking plates, the distance over the latter being 33 ft. 8 in.

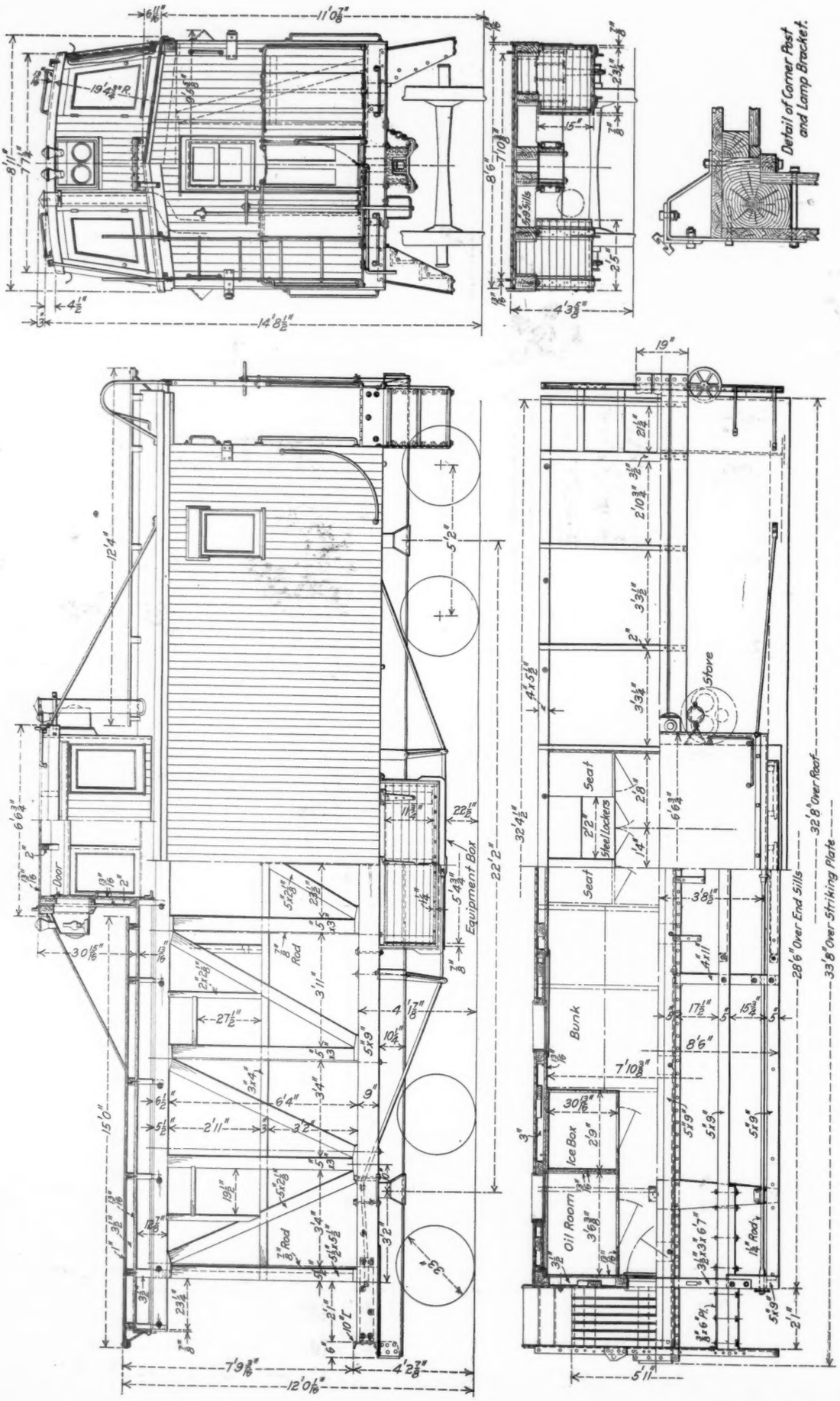
The center girder consists of two 10 in., 35 lb. channels placed 12⅞ in. back to back, and a ¼ in. top cover plate extending the full length. The platform end sill is a 10 in., 15 lb. channel and is connected to the top of the center sill by angles. The body

End View of the Erie Caboose

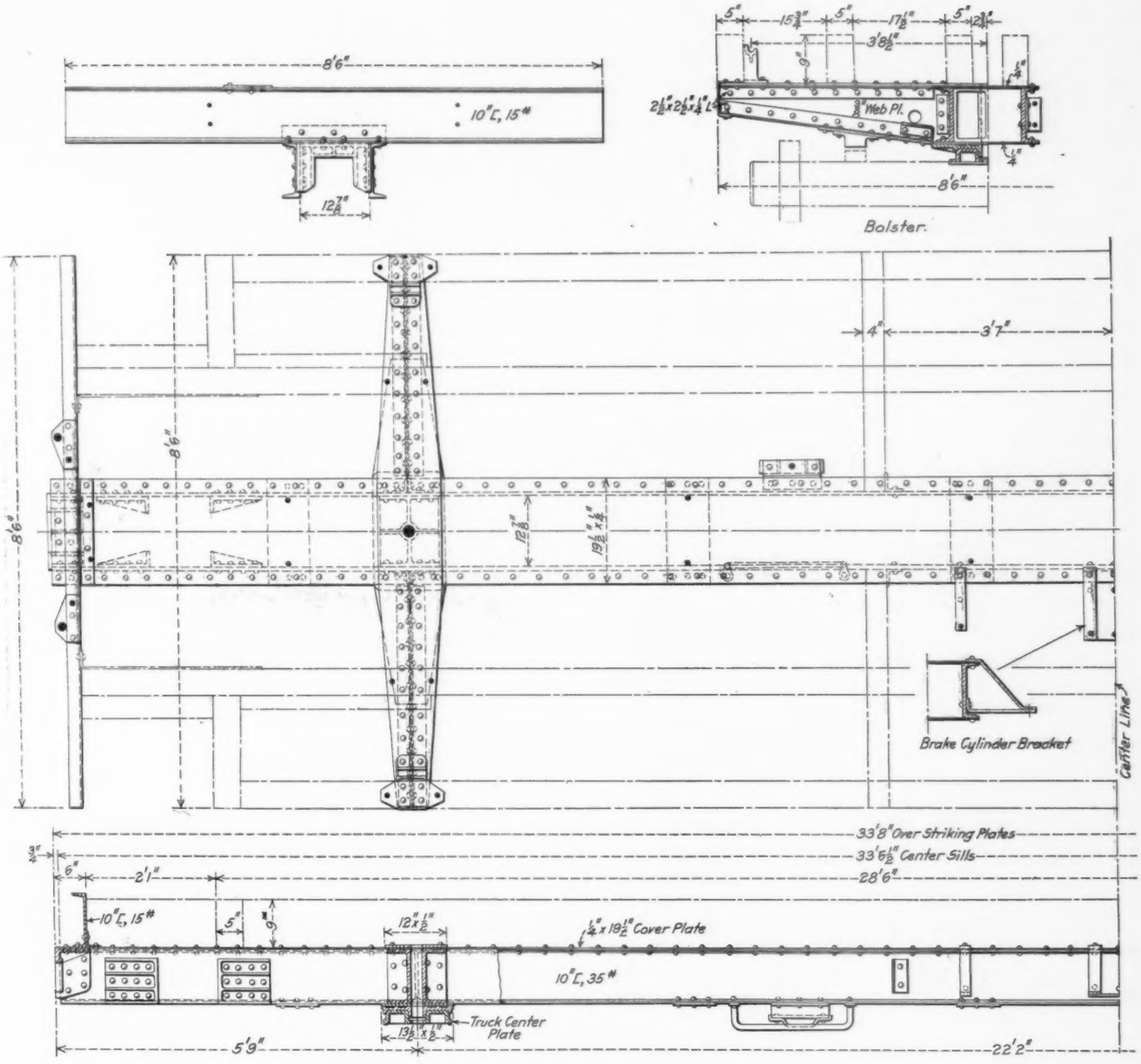
bolsters are built up of ⅜ in. web plates, with 2½ in. by 2½ in. by ¼ in. angles acting as top and bottom flanges on both sides, and a ½ in. top cover plate extending the width of the car. There is also a ½ in. bottom cover plate extending just beyond the side bearings. The truck centers are 22 ft. 2 in. apart.

The wooden sills are 5 in. by 9 in., and rest directly on the cen-

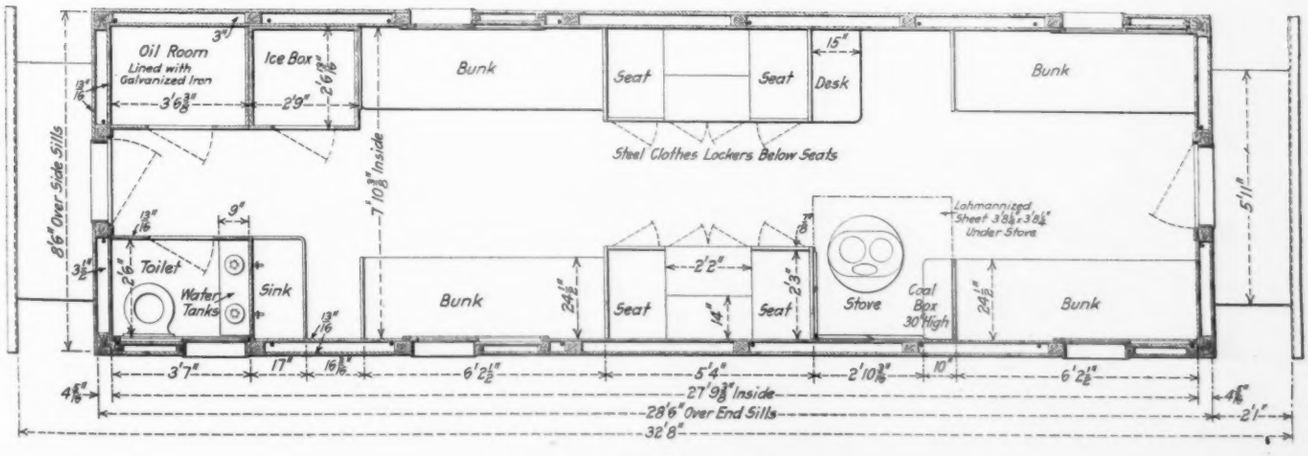
The Steel Members of the Underframe of the Erie Caboose



Elevations and Sections of the Erie Caboose with Steel Center and End Sills and Body Bolsters



Arrangement of the Steel Members of the Caboose Underframe



Floor Plan of the Erie Caboose

ter girder and body bolsters, while two truss rods, one on either side of the car at the outside, pass over wooden needle beams placed 3 ft. 7 in. on either side of the center line. The draft gear stops are riveted directly to the 10 in. channels which form the center sills. The wooden center and intermediate sills are carried through to the platform end sills, these extensions forming sills for the platform which is 2 ft. 1 in. wide. The steps are of steel construction with wooden treads.

The car is 32 ft. 8 in. long over the roof and 8 ft. 11 in. wide over the eaves. The cupola extends nearly the full width of the car at the base, tapering to a width of 7 ft. 7¼ in. over the eaves; it extends 6 ft. 6¾ in. lengthwise of the roof. The car is 14 ft. 8½ in. high over the cupola roof at the center. Special attention has been given to making the interior arrangement as comfortable and convenient as possible for the trainmen. The weight of the car is 38,700 lb.

Wooden Caboose with Steel Center Sills and Body Bolsters

RELATION OF THE PAINT SHOP TO THE REPAIR YARD*

BY WM. BUCHANAN
Foreman Painter, Delaware, Lackawanna & Western, East Buffalo, N. Y.

There is no money expended in the maintenance of railway equipment that gives more value than that used in protecting a car well with paint. On the steel car, rust and corrosion soon take place, caused from sulphur, dripping, etc., and the car becomes weakened and is a source of danger in transit.

On the road with which I am connected it is considered necessary to repaint steel cars once in three or four years, covering all portions of the car, and as far as my observation has gone the stenciling is always legible and most of the exterior of the car is in good condition. We employ a system of painting the cars in series, so that no haphazard painting is resorted to. Our wooden cars give a longer term of service. However, those which have steel underframes require closer checking and if we discover the frames are rusting we scrape and paint them and the steel roofs whenever conditions warrant it. In most cases, no attention is given to the metal parts underneath a car, whereas they should be well protected.

Next in point of importance is the steel or semi-steel roofing. It is very important that this should be kept in first class condition in order to preserve it. The underside as well as the outside should be well painted when the car is being constructed, for the most deadly enemy to steel is moisture and there is no place where it is more apt to lurk than in the hidden parts of car construction.

One of the most expensive operations in painting cars is stenciling, and it should be done with a desire to convey as plainly as possible the information desired. First, the names and numbers of all cars should be in a uniform place, so that any one may know at all times just where to look for them. I am glad to say that a movement is at last under way to get the car owners to adopt a system of uniform standards of lettering.

The officers of some roads have advanced the idea that the painting of freight cars cannot be done during the winter months, especially in this climate and out of doors. During the year 1907, when we started the work at our East Buffalo shops, we painted, 1,413 cars. Nine cars were painted in January, three in February and two in March, so that we were practically at a standstill for three months. During 1909 we painted 2,198 cars; of these we painted 156 in January, 128 in February and 182 in March. In 1914 we painted over 3,000 cars, of which 177 were done in January, 158 in February, 165 in March and 122 in April. I think these figures show that we have been wrong in assuming that work of this nature could not be done during the winter months. Previously our year's total output was reduced, and we were obliged to lay off men of some experience who were of more value than new men, due to the fact that in working together, they become more efficient and can accomplish more work.

As most of the work done is in the open air, tracks should be assigned for this special purpose so as not to interfere with the repair men. The weighing of cars is no small item and should be entrusted to a reliable man who, after the cars are weighed, can put on the new weight, giving a report of the old

*From a paper read before the Niagara Frontier Car Men's Association, Buffalo, N. Y., December 16, 1914.

as well as the new weights so that the proper reports can be made.

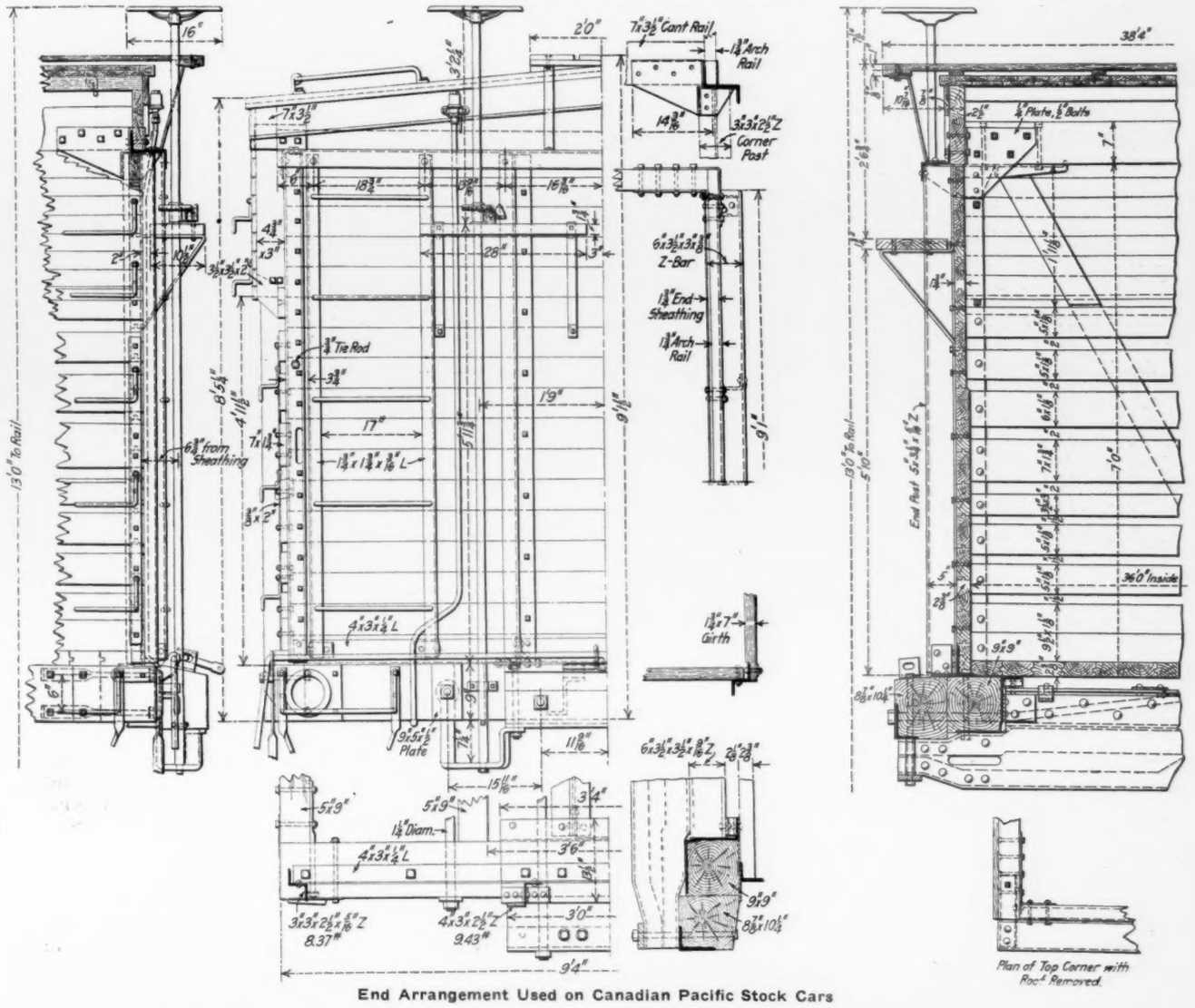
The men who are assigned to look after the repair yard must at all times be on the alert, for whenever cars are undergoing repairs, more or less of the sheathing is ripped off, destroying the stenciled information which should be replaced before the car goes back into service. One item is wrong door numbers, due to the fact that an old door from some other car has been used instead of a new one. This is a source of confusion to those who are obliged to take numbers, as often the number is taken from the door instead of the side of the car.

The reclaiming of paint skins and settlings is an item that should be thoroughly looked after, for considerable money can very soon find its way to the scrap pile if the stock man is not watchful. He should also be responsible for tools and brushes given out each day and see that they are returned at the end of the day's work and placed where they belong. A suitable building for the storage of oil and paints is essential as well as modern devices for mixing paint, and sanitary quarters should be provided for the workmen.

OXYGEN IN BLAST FURNACE PRACTICE.—If oxygen is added to the air-blast for a blast furnace, so that it is present to the extent of 23 per cent in the air instead of the normal 21 per cent, there is a saving of from 110 to 130 lb. in the amount of coke required to smelt a ton of iron, and the iron produced is said to be of a higher quality.—*Scientific American.*

END CONSTRUCTION OF CANADIAN PACIFIC STOCK CARS

The fact that stock cars are used for many other kinds of freight, such as lumber, rails, ties, etc., seems to have been ignored by many designers and builders. As a matter of fact, if a careful check were made on some roads it would probably be found that stock cars are used for this class of traffic considerably more than for livestock. Even though the percentage of this traffic does not run high, the ends of stock cars will, on the average, receive more severe end shocks than box cars because, with the exception of rails or similar loads of steel, the majority of the materials loaded in them are piled high in the car and some of them, particularly pipe and pulpwood, are slippery, which causes them to produce heavy shocks; on the other hand box cars, being used for a greater variety of lading, do not so frequently have a load of this description.



End Arrangement Used on Canadian Pacific Stock Cars

This condition is not taken care of in many designs, and for this reason the end arrangement of the latest type of car built by the Canadian Pacific may be of interest, as illustrating how a substantial end may be easily and economically applied to a car of otherwise standard construction. This car is a standard design that has given excellent service for some years, but the newer cars have been constructed with steel center sills in connection with reinforced ends to eliminate draft gear troubles.

The end construction consists of two 5 in. 11.6 lb. Z-bar end posts, heavy angle corner posts, a 5 in. 11.6 lb. Z-bar end plate

securely attached to the end posts, and corner posts securely attached to the wooden side plates by means of gussets with several bolts through the timber. The lower ends of the end posts are connected to a sill plate passing over the top of the wooden end sill and riveted to the steel center sill, firmly uniting the center sill construction and the end framing. The end lining consists of 2⅜ in. tongued and grooved pine or spruce for a height of 4 ft. above the flooring, with 1¾ in. thickness the balance of the height.

This construction produces a car that is economical in first cost and will satisfactorily withstand ordinary service conditions either for stock or other lading.

The last order of these cars was equipped with socket castings inside of the slats to support temporary decks. This temporary deck is so designed that if similar castings are applied, the same deck will be interchangeable in any 36 ft. car. When these castings are applied to a car, the sheathing board immediately below the fascia is removed to provide ventilation for lading carried on the upper deck.

JOINT CAR REPAIR SHOPS AT LARGE TERMINALS*

BY F. C. SCHULTZ
Chief Interchange Inspector, Chicago, Ill.

Joint repair shops should be established in districts in which a large number of industries are located, so that after bad order loaded cars arriving in these territories are unloaded, they can be repaired and reloaded. This avoids hauling the car back empty to the delivering line, and also creates a supply of good order cars for loading at industries in such districts. If such cars were repaired, it would also avoid the necessity of the hauling of a large number of empty cars into such districts for loading.

The available cars for such joint shops in Chicago, for example, would amount to about 250 cars per day, including both light and heavy repairs. In addition to the cars that accumulate in these territories, provision should also be made for forwarding to such shops, foreign bad order cars which accumulate in the terminals of railroads in the vicinity so as to entirely relieve the railroad companies' shops from the necessity of repairing foreign equipment. It is far more economical to carry such necessary foreign material as is needed at a joint shop than it is to carry a supply at each of the shops of the various railroads entering a large terminal.

The M. C. B. Rules which went into effect on October 1, 1914, and in particular rules 1, 2 and 120, have brought about the accumulation of a large number of foreign bad order cars; if such repairs were made at a joint shop, a great deal of the material removed from the cars which the car owner orders dismantled under rule 120 could be used when making repairs to foreign cars. If joint car shops were established, an organization should be created to supervise as follows:

First: To authorize repairs that are necessary by making an inspection of the cars.

Second: To see that the repairs are properly made.

Third: To see that bills are properly rendered for the work done.

One of the great advantages to be gained by having a joint car shop would be the creation of a car supply, thereby saving a large amount of money, both in intermediate switching charges and per diem which accumulates while such cars are being moved back and forth. The delay of moving such cars to repair tracks for repairs should also be considered.

To illustrate, if a car moving under load from one railroad to another via a switching line to an industry is found in bad order on unloading, it is returned to the switching line for delivery to the originating line where the repairs are finally made. A joint car shop would reduce the switching and make the car available for loading more quickly, as well as reduce the liability of damage due to accident on account of handling bad order cars.

Another matter that would have to be looked into, would be the question of the proper amount to be allowed to the terminal line for switching charges to and from such shops. When a car is delivered to a switching line under load, a switching charge is made which carries with it the return of the empty car to the originating line. The movement of cars from industries, after they are unloaded, to the shops for repairs would be about the same as though the cars were returned to the originating line empty, and switching charges should only be allowed for the service of switching the car from such shops after the repairs had been completed. This, however, would not apply to cars delivered empty to such lines by railroad companies for repairs at such shops; in such cases separate rates should be made.

*From a paper presented at the December meeting of the Car Foremen's Association of Chicago.

DEFECTIVE BOX CARS*

BY L. BROWN

The most important defects in box cars are those which cause a lack of thorough protection to lading. A box car is housed for the definite purpose of protecting freight against loss and damage and any car which is built for this purpose should be so designed that under ordinary wear and tear, with reasonable maintenance, all parts should combine to give thorough protection during the full life of the car. The box car has been developed and used on this continent much more than elsewhere and even today foreign countries are moving their freight largely in open-top cars covered only with waterproofed cloth.

The superstructure of a box car is an expensive article compared with that on a gondola car and much more is expected of it in the way of protection of lading. The defects which cause this lack of protection can usually be attributed to faulty design, poor workmanship, rough usage or lack of maintenance. Designers are, too frequently, not in close enough touch with the cars they have designed, and are working on new designs before the defects in the previous ones have been developed far enough, or discovered at all. This condition is more liable to occur when railroads want cars in a hurry, which is usually the way they want them. A car often shows weaknesses after several years of service which were not apparent when it was new. Much poor workmanship is caused by men working under the piecework system; under these conditions they will not waste a minute to make good a defect which can be hidden, and this frequently occurs when the system of inspection is lax. Rough usage is something for which the operating department is chiefly responsible, but the car designer, builder and repairer can each do their share to prevent its bad effects.

The most common defects which cause loss and damage are in roofs and doors. The remedy for these defects lies in eternal vigilance and a constant lookout should be kept for signs of weakness. Much good information can be obtained by inspecting cars in rainy weather and by watching cars traveling when loaded; by car designers getting in touch with operating conditions and obtaining information from those in a position to regularly observe cars in service and on repair tracks. Any part of a car should be of such a nature that with reasonable maintenance it will give satisfaction during the whole life of the car. Designs should be simple but efficient and a few dollars spent in careful designs may save many times as much money later. The railroads cannot spend money to better advantage than to see that the designs of their box cars are carefully made and thoroughly considered in the smallest details and, if necessary, thoroughly tested before the building of large numbers of cars.

*Entered in the car department competition which closed October 15, 1914.

SHOP PRACTICE

HANDLING WORK REPORTS AT ENGINE HOUSES*

BY JESSE E. TEFFT,
Chief Clerk, Motive Power Department, New York Central & Hudson River, Peekskill, N. Y.

The report of work required on locomotives at engine houses on one of the main line divisions of a large eastern railroad is handled with the use of three forms. That shown in Fig. 1 is used for reporting the condition of the locomotive at the end of the trip and of the air brake equipment when leaving the terminal. The form in Fig. 2 is used to indicate the condition of the locomotive at the end of the trip and that in Figs. 3 and 4 is the locomotive work card. The practice is uniform at each point on the division.

The form in Fig. 1 is in book form containing 150 or 300 pages, according to the size of the terminal at which it is used, and shows the condition of the air brake equipment, also of the injectors on locomotives arriving. Entries are made in black ink by the work report clerks from the dictation of the engineman who signs the book with his full name in ink before leaving the office, each item being marked "O. K." or "Not O. K." as the case may be. After the air brake equipment has been inspected and the necessary repairs made the book is also signed in the proper column by the workman who cares for this class of work. This renders it easy to place responsibility for failure of this equipment if such failure is due to neglect in maintenance or to the engineman not reporting the defects.

The form shown in Fig. 2 is in book form, containing either 150 or 300 pages, according to the size of the terminal where it is in use, and entries are made in black ink by the work report clerks from the dictation of the engineman on arrival. Each item of work reported is shown separately and numbered in consecutive order, commencing with No. 1, for each locomotive. For example:

Right injector does not prime.....No. 1
Clean out tank wells.....No. 2
Repack right trailer box or examine brass.....No. 3

The numbers of each item are shown in the column at the extreme right-hand side of the page.

Condition of Locomotives at end of trip, and of Air Brake Equipment before leaving terminal.

Date Buffalo 5/25 1914

Loco. No.	SAFETY VALVE		AIR PRESSURE		CONDITION OF				SIGNATURE OF ENGINEMAN	AIR BRAKE EQUIPMENT INSPECTED BY ME AND FOUND IN GOOD CONDITION BEFORE LOCO. LEFT THIS TERMINAL (To be signed by A. B. Insp.)
	Lifts at Lbs.	Seats at Lbs.	Reservoir Lbs.	Train Line Lbs.	INJECTORS Right	INJECTORS Left	Gauge Cocks	Glass Water Gauge		
3000	200	195	130	110	Not OK	OK	OK	OK	James J Brown	John Doe

Fig. 1—Form Showing Condition of Engine at End of Trip

Condition of Locomotives at end of Trip.

Date Buffalo 5/25 1914

Loco. No.	The Locomotive is in good condition, with following exceptions (To be signed by ENGINEMAN and INSPECTOR)	Disposition of each item of work Reported 1. Repaired 2. Work not Necessary 3. Held over	No. of forms M. P. 34 Issued for each Loco.
3000	Right Injector does not prime	1	1
	Clean out tank wells	1	2
	Repack right trailer box or examine brass	1	3
	James J. Brown		

Fig. 2—Form for Reporting Locomotive Repair Work

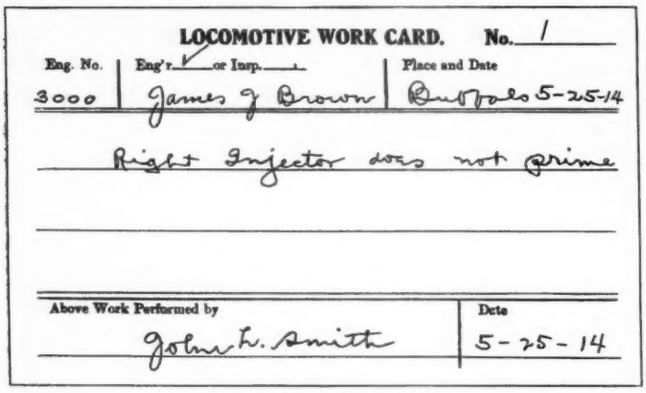
It might be said here that a vigorous campaign of instruction is conducted by the road foremen and assistant road foremen of engines among the enginemen to educate them along the lines of rendering clear and concise reports covering the existing defects as nearly as possible. This means a saving in time for the engine house force as it relieves them of the necessity of searching for the cause of the trouble.

Each engineman signs his full name in ink under the items

*Entered in the competition on Engine House Work, which closed July 15, 1914.

reported by him on his locomotive. If an engineman has nothing to report his locomotive number is entered, and he signs the book over the words "No Defects." Any work not reported by the engineman, and found necessary by any of the inspectors, is also entered in this book in red ink by the clerk and signed for by the man making the report.

The small work slips shown in Figs. 3 and 4 then come into use. Work reported on the form in Fig. 2 is transcribed by the clerk to these slips, a separate slip for each item reported, the numbers of the slips corresponding with the numbers of the items shown in Fig. 2. The slips are distributed to the sub-


LOCOMOTIVE WORK CARD. No. 1

Eng. No.	Eng'r ✓ or Insp.	Place and Date
3000	James J Brown	Buffalo 5-25-14

Right Injector does not prime

Above Work Performed by	Date
John L. Smith	5-25-14

Fig. 3—Work Report Slip

foremen by the engine house foreman, being given out according to the nature of the work, boiler work to the foreman boilermaker, oiler's and doper's slips to the head oiler, machine work to the gang foreman, etc. These foremen distribute the slips to the men who actually perform the work.

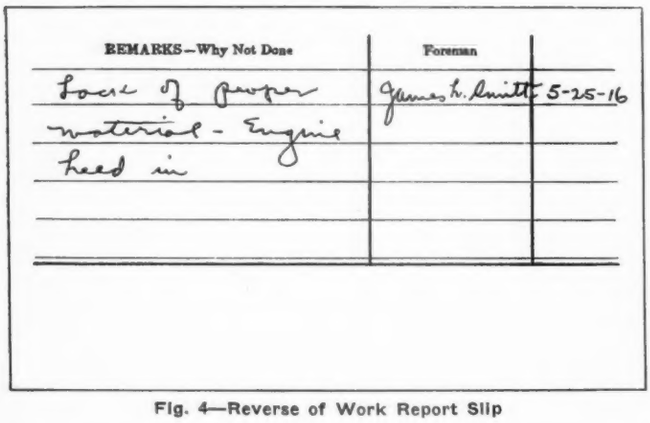
The work slips are divided into three classes, as follows:

1.—Includes all forms showing defects which were remedied before the engine was despatched.

2.—Includes all forms for repairs which in the judgment of the foreman are not necessary.

3.—Includes all forms covering defects that were not remedied before the engine was despatched.

First-class slips must be properly dated and signed with the



REMARKS—Why Not Done	Foreman	
Lack of proper material - Engine held in	James L. Smith	5-25-16

Fig. 4—Reverse of Work Report Slip

full name of the workman who makes the repairs. Second-class slips are marked with the words "not necessary" by the engine house foreman, who signs and dates them across the face. Third-class slips must show on the back why the work was not done before the engine was despatched, over the engine house foreman's signature and the date of signing. As soon as each slip is completed it is deposited by the workman in a box provided for the purpose in the engine house. These slips are collected by a messenger and taken to the work report clerk who checks them off in the book, Fig. 2, as follows:

For first-class slips a figure 1 is placed opposite the item in the column headed "Disposition of each item of work reported," Fig. 2. For second-class slips, a figure 2 is placed in the book, and for third-class slips a figure 3 is used.

After being thus checked off the slips are filed in a separate cabinet provided with two compartments for each locomotive number, a large one for first and second-class slips and a small one for third-class slips. This cabinet is shown in Fig. 5. This keeps the slips covering unfinished work separate, and they are again delivered to the workmen on each subsequent arrival of the locomotive until the work reported is completed, when the figure 3 in the book shown in Fig. 2 is circled and a figure 1 is placed opposite it, indicating that the repairs have been made. Slips covering work reported on engines going to the main shops, or sent for permanent assignment to some other point, are forwarded by mail to that point and after the work is done are returned, checked off, and filed away, thus making the record complete. Before the 15th of each month all first and second-class slips for the preceding month are removed and filed in packages properly listed, together with the completed books, Figs. 1 and 2, for further reference.

It will be noted that a perusal of the book shown in Fig. 2 will show just what was done with each item reported, and while

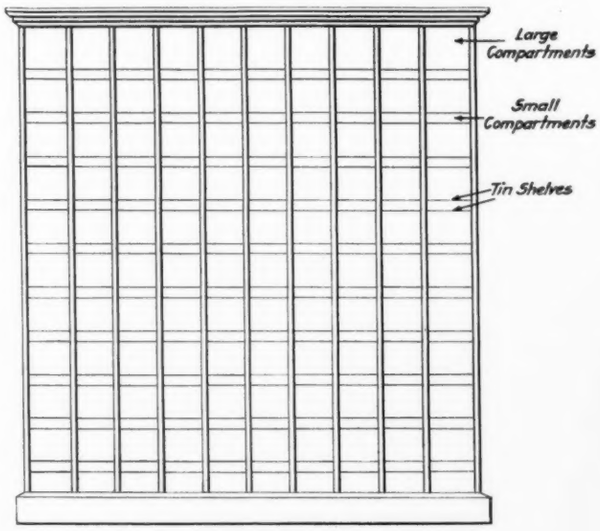


Fig. 5—Work Report Filing Cabinet

it may seem that this system is too intricate for practical purposes, actual practice proves that such is not the case, as it has been in use for three years with very good results. With this method it can be very quickly determined just what work was reported on any locomotive by referring to Fig. 2 and then from the number of the slip listed therein, the work slips can easily be located from which the signature of the workman who made the repairs and the date they were made can be obtained. The fact that such an absolute record is possible with this system has a tendency to make the workmen more careful as they know that they can be closely checked up for each item of work done. The form shown in Fig. 2 also furnishes a rapid and accurate means of determining the number of arrivals and the number of engines repaired at a given point for any period desired, which is something that required a great deal of time to complete before this system was inaugurated. The cost of installing this system is not great, because, except at large terminals where a great many engines are handled, the system can be taken care of by the regular engine house clerks in addition to their other duties.

Tool Makers.—Until a manufacturer reaches the stage where he can employ steadily the minimum number of tool makers, a toolroom is a rather expensive proposition.—*American Machinist.*

RIVETING IN STEEL CAR CONSTRUCTION

A Brief Discussion of Rivet Manufacture; Operations Which Are Necessary to Secure Tight Rivets

BY H. A. HATFIELD
General Foreman, Canadian Car and Foundry Company, Montreal Que.

I

One of the prime factors upon which the strength of a steel car depends is the riveting and its appearance may be permanently marred by careless workmanship or the use of improper tools. Tight rivets of uniform shape and size, without collars or marked plates, can only be had by studying the details of every operation in the history of the rivet. This history begins with the ordering of the stock and includes the arrangements made for storing it from the time it is rolled till the rivets are driven as well as the operations of manufacturing and driving.

THE RIVET

Stock for rivets should be purchased to specifications and carefully checked by the purchaser's inspector. Particular attention should be paid to the diameter of the bars as a very small variation over size will make them too large to go through the dies without leaving heavy fins on both sides of the shank of the rivet, while if the stock is undersize, the dies will not grip it and the header will shove it back instead of upsetting it. Rivet material should be stored in a dry place under cover, and should be stocked in small quantities in order that it may be used before being damaged by rusting. The rust comes off in

Rivet Heading Machine with Overhead Crane and Storage Bins in the Background

the dies, making it impossible to produce clean rivets from very old stock. It also spoils the bottom of the furnace. Poorly made steel rushed through the various operations in manufacture and steel made by rerolling or "bushelling" scrap are particularly liable to corrosion and pitting. If the bars are very badly pitted, the shanks of the rivets made from it will appear to have been overheated, and they may be scrapped as burnt by the heater boys in the riveting gangs. Difficulty will be found in heading stock that has rusted very badly because it will be under size and the dies cannot grip it. There will also be trouble in driving, due to a lack of material to make a full head; and because of the weakened cross section, pitted stock has a tendency to bend rather than to upset. For the same reason the supply of rivets kept on hand should be small. Open rivet bins collect a great deal of dust and this, together with moisture, stray electric currents, and the gases in the shop, is the source of rapid corrosion.

Broken rivets, though generally attributable to poor material, are sometimes the result of improper heating of the rivet stock. Very few machine hands really know how to heat, and tend to get too much material into the furnace at one time. Before it is worked up the last few bars have soaked so long that the metal will be soft and spongy. Rivets made from such metal have a very crystalline structure and are very brittle when cold. This should be explained to all operators and they should be particularly warned to shut down the furnace when delays occur for slight repairs, etc. Another prevalent practice is to make rivets before the stock is heated hot enough to flow properly, and as a result the edge of the rivet head is cracked all around. The reason neither of these conditions causes very much trouble lies in the fact that the heating for driving really acts as heat treatment for metal not too greatly changed in structure, the hammering completing the cure. Those previously heated to excess waste so rapidly that they are scrapped.

If the volume of work justifies it, the best and cheapest method of handling the stock and product is to install an electric crane, though provision should be made for handling by hand in event of any accident to this equipment. It may also be handled by means of an industrial railway and an elevator for lifting the trucks to the top of the bins. This method takes more labor for handling purposes and considerable floor space that with the crane system can be utilized for other purposes. Whatever system is used the boxes can be arranged close enough to the machine for the rivets to fall directly into them, and save the time and labor necessary for shoveling. A small jib crane near the machine may be used to lift the boxes and to change dies.

In choosing a heading machine a multiplicity of parts is to be avoided; the die gripping mechanism should be positive and the attachments easy to adjust. The output may be seriously affected by the time required to change dies after the machine has been used for some time because of the time lost in packing out dies and otherwise trying to correct the wear on the slides. No amount of packing will compensate for worn slides. The rivet heads may be off center owing to the header rising or swerving to one side, or the shanks out of true because of the lost motion in the gripping slides. For these reasons the machine chosen should be designed with some arrangement enabling accurate alinement to be maintained. It is preferable that scale and water should not fall on the slides, as this is the cause of a greater part of the wear.

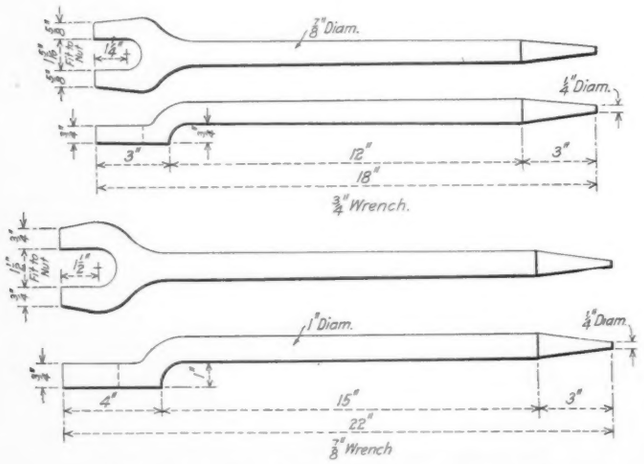
Rivet machine dies should be made of a good alloy steel ordered specially for this purpose. Carbon steel may serve for rivets made in small quantities, but for long runs on the larger sizes the edges of the passes will fail, the temper being drawn by the hot work. Such a pair of dies will outlast several pairs of carbon steel and repay the higher first cost not only in replacement, but in machine time saved and in the quality of the output.

Unless special precautions are taken, some difficulty may be

had in getting the two dies to line up in the machine owing to the variation in the distance from the center of the passes to the face resting on the slide. A method which prevents such trouble is to clamp the two die blocks together and machine them up square, then put them on a surface plate and lay off the center of the passes from the plate, so that this important dimension is always the same. The most economical dies are made with two passes on the side; if only a small number of rivets are required of one diameter and length, the bore of the different passes need not be the same. Worn dies can be redrilled for rivets of a larger diameter, and they may be planed down for shorter lengths as the ends of the passes wear. The bore of the pass is material size, it being the usual practice to roll rivet stock 1/64 in. below size, the expansion due to heating being sufficient to hold the stock under the impact of the header after it has been cut off from the bar. The sharp edge should be taken off the end of the pass next the header to leave a small fillet between the head and shank of the rivet. Different makes of machines require different sizes of die blocks, but the length of the pass equals the length of the rivet plus 1/16 in.

With the exception of the shank the header must be hardened or it will upset, bend or break. Great care should be taken when setting the dies that the header is not off center, as a lop-sided head detracts greatly from the strength and appearance of the rivet. The size of the cup should be gaged frequently, as a worn cup will make big heads and ragged riveting will result.

Every shop has its own standard proportions for rivet heads, and it is unusual to find any two agreeing exactly in size. After a company has tried and adopted certain standard sizes, however, they should be firmly adhered to. A complete set of master gages should be made and kept with the shop records and duplicate sets for machine shop use placed in the tool room. Every department foreman concerned should have a male gage for all the sizes in general use, so that he may know that his tools are in good condition. That the strength of the work, especially single riveted joints, is increased by any addition to the weight of the rivet head is true; but it is not advisable to go beyond the usual sizes given in the hand books on structural steel, as the increased strength is obtained at an increased cost for rivet stock, the output from each riveter is decreased, owing to the trouble in keeping the greater lengths from bending in the machine, and a greater number of rivets are driven loose because of the increased difficulty in getting the shanks to upset in the hole. On the other hand the



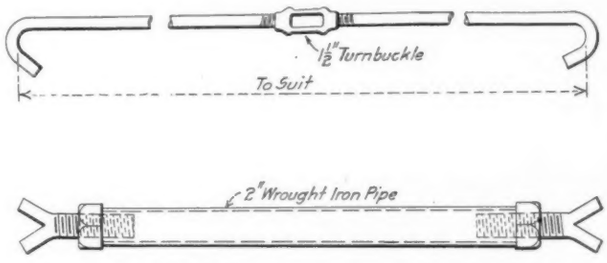
Wrenches for Use in Assembling Steel Cars

head should not be made too shallow as it is liable to snap off in tension, nor should it be spread so that the diameter is out of proportion to the height, or the material be distorted in forming.

ASSEMBLING

Granting that the forming is well done and the punching is accurate so that the holes match well, it is of the greatest importance that all parts be bolted together so closely that the rivet cannot spread and form a collar between them which will hold the two surfaces apart. All work should be lined up by means of gages and straight edges and bolted so solidly that the reaming will not disturb it. Wrenches for assembling should be made similar to those shown in the engraving, the pointed ends serving as pins which may be used to pull the parts into line. The handle may seem long but as it is positively necessary to have the parts of the work drawn close together, short handles should only be used when space does not permit the use of long ones. Medium weight sledges with smooth faces and no sharp edges to mark the work may be used to drive the parts to place. Benches or trestles for assembling purposes should be strongly made. A light rail spiked to the top will facilitate handling heavy work. Jigs for the sides, ends, etc., should be of heavy construction so that they will retain their accuracy under rough handling.

All work should be assembled with bolts the same size as the rivets to be driven; punching not allowing for this should



Brace and Clamp for Use in Assembling Steel Cars

not be accepted. Bolts with special coarse threads should be made for assembling, 7 threads per inch for 5/8 in. bolts and 6 threads per inch for 3/4 in. bolts. The standard thread wears too rapidly for this work and the bolts cannot be rethreaded as many times, nor can they be tightened up as quickly. Washers for assembling may be made cheaply from scrap of various thicknesses. Nuts that are too big to be retapped are suitable if used with a plate washer next the work. The supply of bolts should be plentiful and include a number of lengths as it is often necessary, in case of a projecting flange or two bolts coming close together, to use a long bolt and a number of washers in order to get the nut in such a position that the wrench can be used to advantage. Numerous attempts have been made to get away from the bolt and nut as a means of fastening, and various kinds of clamps tried, but those found powerful enough to close up the work are expensive to make in the quantities required.

Drift pins are best made of a good tough steel high enough in carbon to make them stiff but not enough for them to fly under the impact of the sledge. Old reamers or dies drawn down are dangerous for this reason. Braces should be made of 1¼ in. round stock, the threaded end being upset for a 1½ in. turnbuckle. Spreaders may be made of pieces of pipe in which a fork threaded to the head, with one nut on it, is inserted. Jacks of various sizes and kinds, a number of strong clamps and several chains of different sizes complete the assembler's outfit.

REAMING

It is quite usual to find the reaming handled by the least intelligent men in the shop, for the air motor is heavy and the work monotonous, but no man should run one of these machines until he has had its principles explained to him and he knows enough to see that it is properly taken care of. It is good practice to use one make and size of machine throughout the shop, since then it is only necessary to keep one type of repair parts on hand and all tools are interchangeable. The non-reversible motor is preferable because it is impossible to run the tool in the wrong direction, and the power may be cut off positively

in case of accident. A good air machine weighs about 50 lb., and uses from 30 to 40 cu. ft. of free air per minute at 80 lb. pressure. The work of reaming is carried on under conditions that are far harder on the machine than any drilling within its capacity. Unfortunately it appears that these machines are developed for conditions favorable to drilling; the higher speeds, heavier cuts and lack of positive support—conditions that must be met in reaming—greatly increase the repair bills and necessitate more than ordinary care to keep the machines always in first class order. The prime requirement is to keep them well oiled. There are several makes of grease for use in air motors. Each machine should be partly filled at intervals and one man should be detailed to oil every machine at least once a day.

For car work it is cheaper to make reamer tools than to buy them. Extreme accuracy not being called for, they may be 1/64 in. over size to allow for grinding. The shanks for all sizes should be made for No. 3 Morse taper sockets. By this practice the larger sizes may be recut for the smaller sizes without touching the shanks, and it is necessary to remove the socket from the machine only when replacing it by a new one. Care should be taken with the tang and taper, since a bad fitting tool means time lost in the shop trying to get it to stay in the machine. If the tool is loose in the socket it may drop partly out when the machine is started, break the corner off the tang and spoil the socket; for this reason it is best that all sockets and shanks should be fitted to standard gages and that worn sockets be scrapped. A drift pin should be provided for removing the tools from the socket. The sockets should always be removed from the machine by the last turn of the feed screw, or by a hardened steel rod which is passed through the spindle after the feed screw has been removed. Reamers should be made of high speed steel, as in most cases it is impossible to have water at hand for cooling purposes, and carbon reamers burn up unless water cooled.

It has proved the best practice to use ¾ in. air hose, and as flexibility is not of as great importance as with the riveting hammers, the heaviest kind of armored hose will be found the cheapest for this work; ½ in. hose connections should be used for all pneumatic tools.

The following facts should be impressed upon the reamer operator: That a reamer is a high priced machine, not to be subjected to unnecessarily rough usage; that the parts operate at a high speed under pressure, and unless plentifully supplied with lubricant, the cost for repairs and lost time will be heavy; that there is a critical speed at which the tool works best which is very near the stalling point; that drilling is a different proposition from reaming, the drill being run with the lowest possible speed and the greatest feed up to the stalling point.

The development of the electric drill has been so rapid that it is only a question of time before it replaces the air machine. It is cheaper to install, and costs less for upkeep. There is practically no loss from leakage and no drop in pressure, two things greatly against the air machine; nor do changes of weather and temperature affect it. It has been stated that drilling with compressed air is approximately two to three times more expensive than with electrically operated drills, and the same holds goods for reaming. The two great reasons for not installing electric reamers are the fact that it is still necessary to use air to drive the rivets and that the machines operated by alternating current are not as successful as those using direct current. Since alternating current is largely used for power, the use of direct current accessories would require the installation of a converter set and special wiring.

MACHINE RIVETING

Rivets can be driven by a pneumatic riveter at a lower cost than by a hydraulic riveter or a pneumatic hammer. Space in the present article is not available to do more than state the fact, but it amounts to about 25 per cent saving over the hydraulic machine and nearly 50 per cent over the pneumatic hammer. In addition the rivets are tighter because the toggle effects a gradual application of the pressure which constantly increases as the stroke advances and the shank of the rivet is upset so that it completely fills the hole. It is therefore seen that any work which can be handled to a machine or on which a portable riveter can be employed, should be machine riveted.

There are a number of makers with both stationary and portable riveters on the market, several different types of which are designed especially for car shop purposes. When buying this equipment it is a mistake to get larger sizes than the greater part of the work calls for. The majority of the rivets used being ⅝ in. and ¾ in., machines to drive these sizes and no larger should be purchased. An inch increase in the diameter of the piston and an inch or two added to the length of the stroke may greatly increase the number of cubic feet of air used. This is decidedly expensive, for according to Hiscox a two stage compressor under the best conditions develops 14.5 hp. in compressing 100 cu. ft. of free air per minute to 90 lb. pressure. This means that a machine using 5 cu. ft. of free air per rivet, driving 20 rivets per minute, allowing for leaks the uses 16 hp. Since a little over half this volume of air at this pressure is required to drive a ¾ in. rivet it is obvious that the best policy is to buy only enough large machines to take care of the rivets in the draft gear, the draw bar yokes, and the few other large rivets that may be required. Unnecessarily large riveters also mean further expense for increased compressor and receiver capacity.

Professors Unwin and Kennedy in a series of tests made in 1881-1885 proved that the shearing resistance of rivets is not highest in joints riveted by means of the greatest pressure and the ultimate strength of joints is not affected to an appreciable extent by the mode of riveting. Very great pressure in riveting is therefore not the indispensable requirement that it is sometimes supposed to be. Further tests proved that if the thickness of the material which the rivet passes through does not exceed the diameter of the rivet plus ⅛ in., and the rivet is hot, 15 tons pressure will thoroughly fill the hole and make a good ¾ in. rivet. As the plate thickness increases, the pressure required increases approximately in proportion to the square root of the increase of thickness. That is, if the total thickness of plate is four times the diameter of the rivet we should require twice the pressure given above in order to thoroughly fill the hole and do good work. It is possible to use so high a pressure as to seriously injure the work. The plates are bruised and bent, and the holes may be subjected to a radial pressure sufficiently great to develop cracks in any but the very best plate. This condition is further aggravated, especially on thin stock, by the heat conveyed to it from the rivet and hot die. Stresses are set up between the hot and cold parts of the plate, a temperature is developed corresponding to a blue heat resulting in brittleness and the development of cracks later on. Most manufacturers issue a double warning with their machine and in their advertising matter. While they point out the impossibility of driving good rivets without an ample supply of air at the right pressure, they try to impress the user with the fact that the pressure cannot be allowed to run above that for which the machines are designed without injury to the machine and the work. Designs are usually based on 150,000 lb. per sq. in. as the pressure necessary to drive rivets. This is the highest value for the crushing strength of cold rivet steel. The real value seldom exceeds 100,000 lb. per sq. in., and it has been proved by actual tests that it takes only one-fourth the pressure to drive a hot rivet that is required to drive a cold one. Therefore the manufacturer's rating is very high and the smaller machines will safely take care of the riveting through any thickness of plate used in steel car construction. In this connection the economy of properly heating the rivets should be noted. It saves the machine, saves air and results in far better work.

The operator of a machine riveter is responsible for the ma-

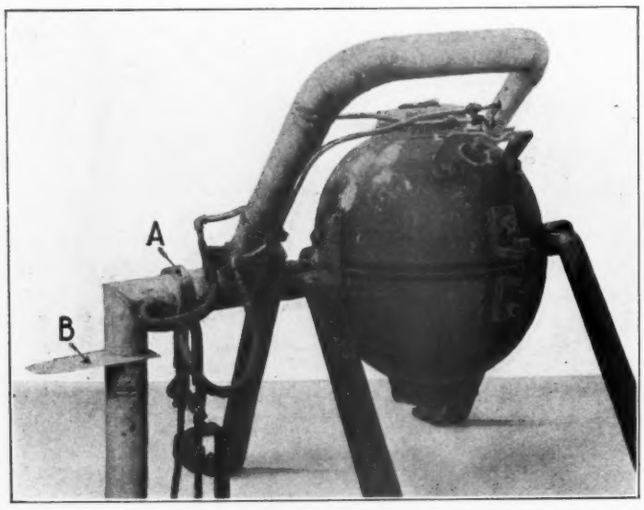
chine and for the work turned out. Before driving any rivets, he should blow out any water that may have condensed in the cylinder and adjust his dies. This is done by letting the ram down and turning the screw till the die presses against the work. The ram should then be raised and the screw given a half turn down. In driving rivets the die should be brought down slowly at first until the ram is nearly out before putting on the full power. A sufficient number of dies should be kept at each machine to allow them to be changed frequently in order to prevent them from spreading, due to the continued heating. They may be paired, a long one with a short one, gradually decreasing one length and increasing the other in such a manner that the space between the dies will remain practically constant and the greatest possible amount of work will be obtained from the steel. By this method a die may be used till its thickness is little more than the height of the rivet head. Special die steel is made by some manufacturers for use without hardening and tempering. Where hardened dies are used the heat soon draws the edge of the cups, and it is necessary to anneal them before they can be recupped. A test is advisable before a selection is made, since there is a wide variation in the number of rivets which can be obtained without recupping.

SIMPLE FURNACE FOR MELTING BRASS

BY R. F. CALVERT

The illustration shows a design of furnace suitable for melting small or medium quantities of brass, which has been used satisfactorily at the Horton, Kan., shops of the Rock Island Lines. With the furnace one-half to two-thirds full it is possible to melt brass in about 30 minutes.

The shell of the furnace, which is 1 in. thick, is made from two hemispherical castings about 24 in. in diameter. The upper casting has an opening in the top for pouring, about 8 in. in diameter, and another opening, a little to one side, for the burner. The castings are lined with a 2 in. layer of fire-brick and the brick is



Furnace for Melting Small Quantities of Brass

lined with a 1 in. layer of fire-clay, except at the two openings. They are then clamped together by means of four lugs and 1 in. bolts. Two of these lugs are formed to act as bearings. They are 3 in. in diameter and are supported by a 4 in. x 1 in. wrought iron frame. Fastened to the outer end of one of these bearings are three wrought iron handles which are used for turning the furnace when pouring. The burner is supplied with a 2 in. blast pipe which has an oscillating joint shown at *A*. This blast pipe also has a slide for regulating the blast, which is shown at *B*.

The burner consists of a 2 in. blast pipe in which are located two other pipes, one for compressed air and one for oil. The compressed air passes through a ½-in. pipe which enters the blast pipe about 4 in. from the nozzle and terminates about ⅛ in. back of the nozzle. The oil pipe enters the blast pipe about 6 in. from the nozzle and terminates inside the compressed air pipe at a point ⅛ in. from its end,

The supply of air and oil is regulated by valves located as shown. Both the compressed air and oil pipes are connected with about 4 ft. of hose which allows the furnace to be turned when emptying. The nozzle of the burner is about 2 in. from the outside of the shell and is formed by reducing the end of the blast pipe to 1¼ in. in diameter. The nozzle is supported by a wrought iron brace bolted to the shell of furnace.

BELL YOKE BEARING REAMERS

BY F. W. BENTLEY, Jr.

There is nothing in connection with the performance of the bell ringer that has more influence on its action than the condition of the yoke bearings of the bell. The necessity in most shops of removing the bell stand and reaming it on a drilling machine for correct alinement makes this a piece of repair work that is very often slighted, with resultant inconvenience to the enginemen.

The accompanying drawings illustrate a simply constructed set of reamers which make this a comparatively short piece of work. The reamer in Fig. 1 is for truing up the holes to 1½ in.; the

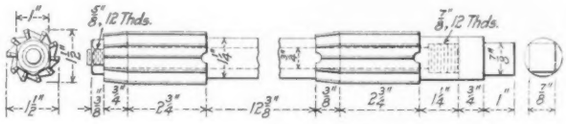


Fig. 1.

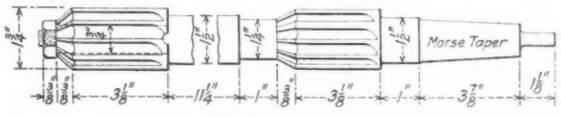


Fig. 2.

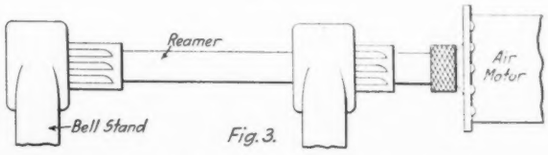


Fig. 3.

Reamers for Truing Bell Yoke Bearings

reamer in Fig. 2 is for reaming the holes when worn over 1½ in. In either case a bushing is then applied to the wings of the stand to take the standard 1¼ in. yoke pin. Both reamers can be used in connection with an air motor and the operation is shown in Fig. 3. Owing to the double nature of the reaming cutters it is quite easy to keep the holes in line. The reamers eliminate all necessity of removing the stand and on one or two jobs of this kind will effect enough saving to pay for themselves.

This method of truing bell yoke bearings has been developed by W. H. Halsey, general foreman, locomotive department, Chicago & North Western, Missouri Valley, Iowa.

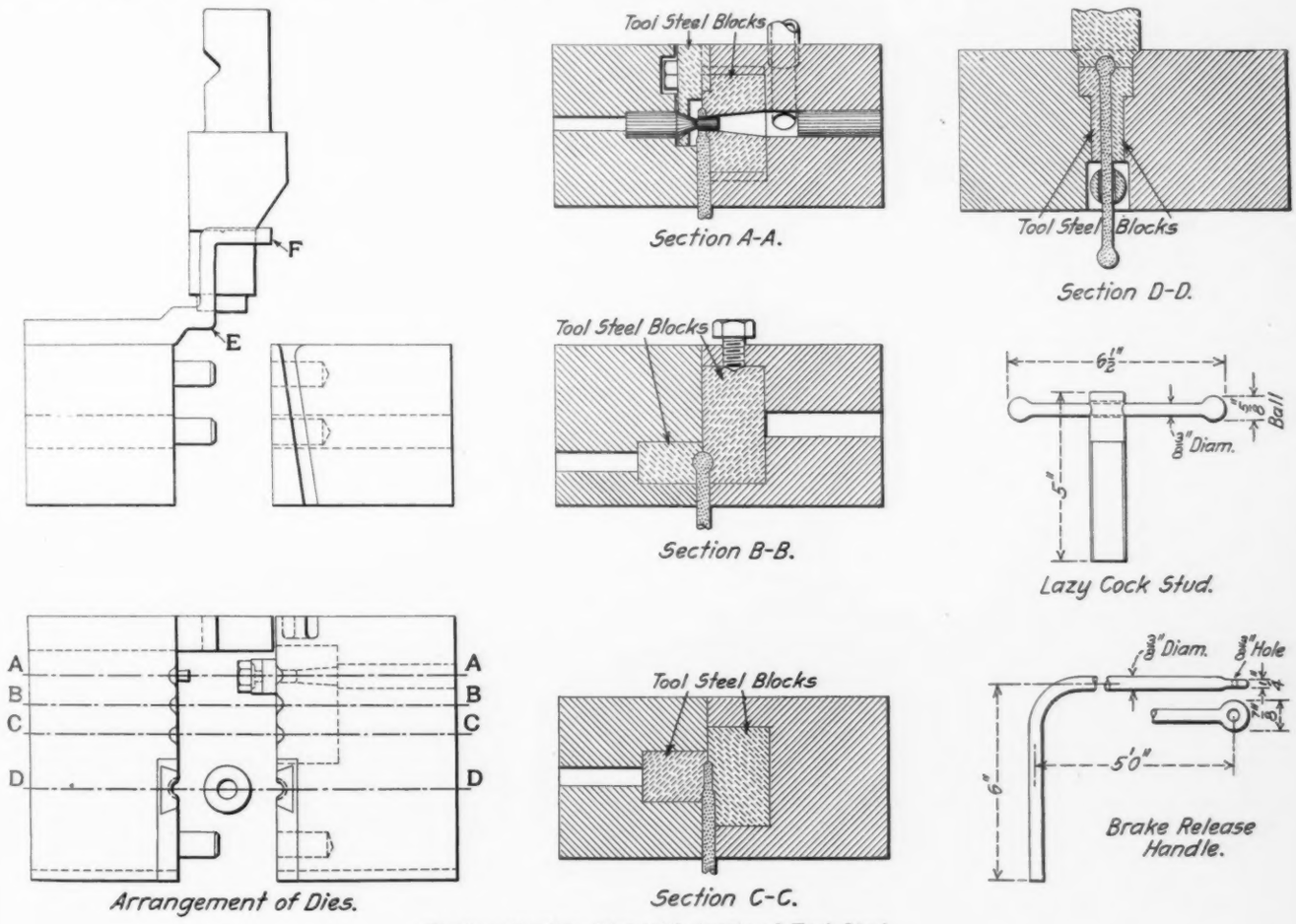
Line Loss.—Conditions may readily occur in connection with electric wiring where the drop may not be sufficient to cause any diffiulty in the operation of lamps or motors, but if the loss over these wires is figured, it will be found advisable to use larger wire, as the interest on the increased cost of the wire will be less than the loss of power by the use of the smaller wire.—*Power.*

FORGING MACHINE DIES

BY J. LEE

The set of dies for a 1½ in. Ajax forging machine, shown in the drawing, has a number of small blocks of tool steel let into the main dies. These are of standard sizes to provide for interchangeability, and many jobs of a similar nature may be handled with the same main die blocks by changing the smaller blocks. This practice materially cuts down die costs.

The dies illustrated are for the manufacture of lazy cock stud handles and brake release handles. These are both made from ⅜ in. round stock, cut to length in a shear. In forming the lazy cock handle one end is first upset, the stock is then put through the hole in the lazy cock stud and the other end is upset in the same die, as shown at section *DD*. This is done in one heat, and when necessary the balls can be trimmed up in the swedging die, section *BB*, to take off any fins. The brake release handles are first upset on one end with the die at section *DD* and are then flattened as shown at section *CC*. The punching die for these handles is shown at *AA*, the die block being drilled and a pipe let into the side to take away punchings. These three operations



Forging Machine Dies with Insets of Tool Steel

are done in one heat. The other end of this handle has a right angle bend. To accomplish this a slot is cut in the top of the stationary die and a bracket is bolted on the side of the moving die. The bracket serves as both gage and bending tool, the part at *E* being the gage and the part at *F* doing the bending, the latter being done cold.

SPECIAL TOOLS.—The making and maintenance of special tools and fixtures are costly, and in order to put the toolroom on a satisfactory basis, system is an essential.—*American Machinist.*

LOCOMOTIVE RUNNING REPAIRS*

BY ERNEST CORDEAL†

It would be a task of no great difficulty to provide motive power of the highest possible efficiency for the movement of all trains, if no limit were placed upon the number of locomotives owned, if unlimited amounts of money were available for making repairs, and if shop and engine house facilities were kept up to the highest state of perfection. Such favorable conditions do not exist, and if they did would not be conducive to moderate operating costs.

Ultimate economy of operation, so far as the locomotive contributes, demands:

(1) That the number of engines owned be no greater than is necessary to handle the peak load of traffic.

(2) That shop facilities be sufficient to complete the necessary general overhauling without the consumption of excessive time in or awaiting shop.

(3) That engine house work be so planned and conducted that locomotives are available for service the maximum number of hours per day and days per month, and that their condition be such as to permit of handling the proper train loads without delays.

The failure to fully realize the third condition makes impossible the fulfillment of the first two. Where running repairs are not properly made, rapid deterioration of the machine must follow. Short periods between general shoppings result. The increased number of shoppings necessarily overloads the main

*Entered in the competition on Engine House Work, which closed July 15, 1914.

†310 Frisco Building, Springfield, Mo.

shops and leads to a poorer quality of general repairs, excessive time in the shop, and long periods of waiting on the hospital track. The purchase of new power is the usual expedient to relieve such a condition.

Again, inadequate running repairs mean low power efficiency. Locomotives will not handle their full tonnage; delays and failures are unavoidable; in order that the traffic may be handled there must be an excess of power. The failure, therefore, to provide for the proper maintenance of locomotives in service is responsible for excessive investment in power; high cost of shop repairs; inefficiency and heavy expense in train operation.

That a high cost of repairs per unit of work performed by locomotives insures the best power condition by no means follows. The contrary is in fact more often the case. The railroads in the United States which handle the greatest amount of traffic with the least investment in equipment, with the lowest train mile costs, with the fewest engine failures, have without exception a moderate unit cost of repairs, while many of those roads which expend unusual amounts in the maintenance of equipment, obtain a low mileage per locomotive per year, have a train tonnage less than the efficient minimum and register frequent delays from power failures.

The condition of power does not necessarily depend upon the amount of money expended in its repair. It does depend upon the time at which the necessary repairs are made. A man might comfortably sustain life with an expenditure of five dollars a week for food and lodging, provided he distributed the amount equally over the period. If, however, he gorged himself to the full extent of his allowance at the first meal he might starve or die of exposure before the next installment was due.

The quality of running repairs, paradoxical as it may seem, depends very little upon the adequacy of the engine house facilities provided. Up-to-date buildings, machinery and appurtenances are a convenience but not an absolute necessity in the proper maintenance of locomotives. It appears at times as though the mere presence of improved facilities for performing the heavier class of repairs leads to a neglect of the minor items. To maintain power in the best condition demands frequent and rigid inspection, and immediate attention to minor defects. If these two requirements are fulfilled, elaborate and expensive engine house layouts will be unnecessary. It is the shoe or wedge not properly adjusted that calls in time for the dropping of wheels to renew driving brasses and turn journals. It is the loose rod key that makes necessary the renewal of a back end brass; the broken follower bolt that knocks out the cylinder head; loose or ill-fitted bolts that break the frame, and the careless use of the beading tool which makes necessary the renewal of tubes. The detection of minor defects and their immediate correction is the whole secret of high power efficiency and low maintenance costs. The usual tendency of engine house forces is to overlook or pass over those minor items of repairs which do not materially interfere with the operation of the locomotive, postponing their performance until such time as defects of a serious nature have resulted. The cost of reducing a brass or setting up a wedge is insignificant as compared with the cost of renewing the brass, and perhaps turning a cut pin, or of dropping the wheels and renewing a driving box brass. The engineer, the engine inspector and the wiper are the agents of inspection. If they are competent, well trained and conscientious the greater number of the small defects, the neglect of which leads to failures and expensive repairs, will be found and reported before they have developed to a serious stage.

The engineer's report should cover such defects as develop during the operation of the engine, and should be made during the progress of the trip and not after arrival at the terminal. For this purpose he should be provided with a work report book of convenient size and shape to be carried in the pocket, so that he may make note of any irregularities which occur in the running of the engine. Many minor defects in the working parts of the locomotive are called to the attention of the engineer while the engine is in motion. If note is not made of such imperfections at the time their presence becomes known they are very likely to be forgotten or overlooked when hurried entries are being made in the engine house work book at the end of the trip.

The engineer should not be expected to make an exhaustive examination of the locomotive after arrival at the terminal. In the first place, he is very infrequently a skilled mechanic and is not, therefore, qualified to make a competent inspection. Again, few engineers at the end of a trip are willing to give the time and attention necessary to complete a thorough inspection. The engine inspector's duties should begin where the engineer's leave off. The selection of competent men as inspectors is a matter of prime importance. Too often the position of engine inspector is filled by a superannuated engineer or a mechanic of inferior rank. Such practice is entirely wrong; the position should be filled by the best mechanic available. The results to be obtained from proper terminal inspection, first, to determine the repairs necessary, and second to pass upon the quality of the completed work, will fully warrant the payment of a salary comparing favorably with that of a foreman.

The inspection of incoming engines should be of the most thorough nature. All parts of the locomotive should be examined, not occasionally, but at the end of every trip, and all of the defects, even to the most insignificant and apparently unimportant ones should be reported and given attention.

The importance of the wiper as a factor in efficient engine house work should not be overlooked. Engines which are covered with grease and dirt cannot be properly inspected. Cracks in frames, rods, blades or other vital parts of the locomotive may be so effectually covered by a coating of dirt that their detection is impossible. Such defects undiscovered will lead to failures in service, possibly entailing the destruction of equipment or the loss of human life. Locomotives may be thoroughly cleaned and kept clean at the cost of a few mills per mile run, and such expenditure is covered many times over by the improved inspection made possible. The wipers themselves may be trained to report to the inspector or foreman defects which they discover while cleaning locomotives, and many break downs and failures may be avoided by their so doing.

Clean engines not only permit of more adequate inspection, but conduce to a higher efficiency of the labor applied in their repair. Almost any mechanic will work with increased energy, and with greater pride in the work when the parts which he must handle are free from grease and dirt.

Adequate inspection provided for, the next necessary step is to insure that the defects discovered are promptly and effectively repaired. The proper performance of running repairs at engine houses depends far more upon the organization of force, and the quality of supervision, than it does upon equipment and facilities. The engine house force, no matter how small or how large, may be so assigned as to give to each individual workman the care of and responsibility for the repairs to certain parts of the locomotive. Ample and competent supervision to insure not only the performance of all work ordered, but to inspect its quality, is a necessity if high power efficiency is to be maintained.

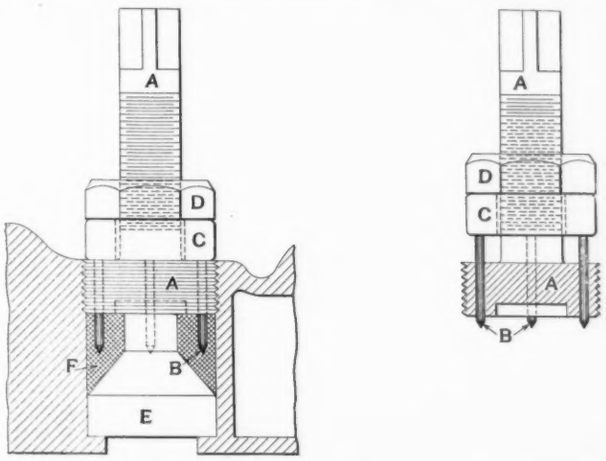
To summarize, the duties of the engine house are: To provide competent and continuous inspection of locomotives in service, to insure the discovery of defects in the incipient stage, and to promptly and effectively repair all defects so found, preventing minor defects from causing, through neglect, the necessity for extensive repairs. Simple as this formula appears, many engine house foremen will raise the objection that the volume of work absolutely necessary to keep the power in service is so great that the less important items of repair must be neglected. At an engine house where this policy has been employed some difficulty may be experienced at first in securing proper attention to defects of a minor nature. In such case it might be well to start with only two or three engines just out of the main shop, giving them particular attention to see that careful inspection is made

after each trip, and that all defects are corrected before the engine returns to service. By the process of gradually taking up more and more locomotives on this plan, it will soon be found that the volume of heavy running repairs has so decreased, that the original force employed will be more than sufficient to keep the power in the best of condition.

REMOVING GASKETS FROM BULLSEYE LUBRICATORS

BY J. A. JESSON
Air Brake Foreman, Louisville & Nashville, Corbin, Ky.

The device shown in the engraving was designed to facilitate the removal of sight feed gaskets from Detroit bullseye lubricators. These gaskets often become stuck in place, and owing to their location below the follower threads, are rather difficult to remove. The body of the device is shown at *A*. It is threaded on the lower end to fit the follower threads in the lubricator body and the stem is threaded to take the nut *D*. Before the nut is applied the sleeve *C* is slipped over the stem, the four attached pins *B* being placed in holes through the body *A*. With

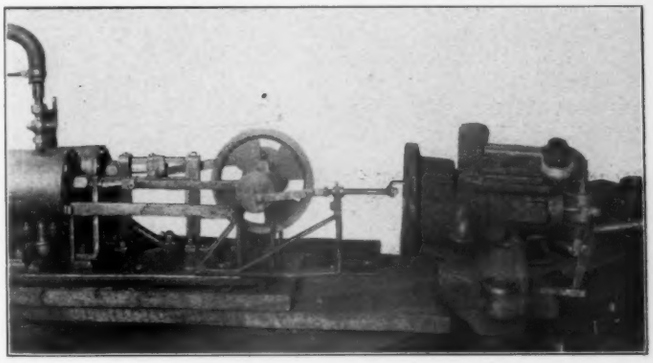


Device for Removing Gaskets from Bullseye Lubricators

the device screwed into position in the lubricator, the nut is turned down against the sleeve, thus forcing the pins into the gasket *F*. The whole device is then unscrewed from the lubricator body, the gasket being loosened and removed by following the threads. The four pins *B* are ⅛ in. in diameter and are made from tool steel. It is advisable to provide a ball thrust bearing in the sleeve *C*, in order to insure a free working nut and to remove the tendency to bend the pins when forcing them into the gasket.

GRINDING DISTRIBUTING VALVES

The accompanying illustration shows a home-made air engine for grinding six different surfaces of the distributing valve of the Westinghouse air brake at one time. The device was invented by W. L. York, of the Ferguson shops of the Cincinnati, New Orleans & Texas Pacific. It is in reality a small engine, equipped with a valve and cylinder, as indicated, the cylinder being the barrel shown on the further side of the engine. The guides for the crosshead are supported on uprights bolted to the base of the machine. The valve is operated by an eccentric on the near side of the flywheel. The crank on the front of the engine oscillates a plunger, which is attached to the application piston. On the back end of this piston rod another rod is fastened, which operates a lever, with a fulcrum, as indicated in the illustration, which transmits the motion to a rod that oscillates the equalizing piston. The device will grind the application piston ring, the application valve, the equalizing valve, the equalizing piston ring, the graduating valve and the exhaust valve all at the same time, and will perform



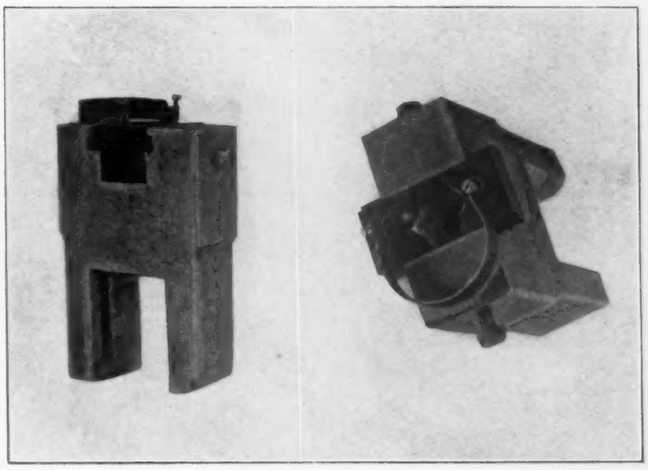
Small Engine Used for Grinding Six Surfaces of Distributing Valves

the job in one and one-half hours, whereas it would require four hours to do the grinding by hand in the usual way. The small engine may be operated by air or steam.

RECLAIMING BOLTS WITH BATTERED THREADS

BY J. P. NOLAN
Assistant Superintendent, Morgan's Louisiana & Texas Railroad, Algiers, La.

It is the general practice in railroad shops when reclaiming old bolts accumulated from the dismantling and repair of equipment to cut off and rethread all those having threads battered or bruised so that a nut will not go on. Where the threads are not badly worn or the material fractured this practice not only wastes a great deal of material but results in a large accumulation of short bolts for which there is no further use.

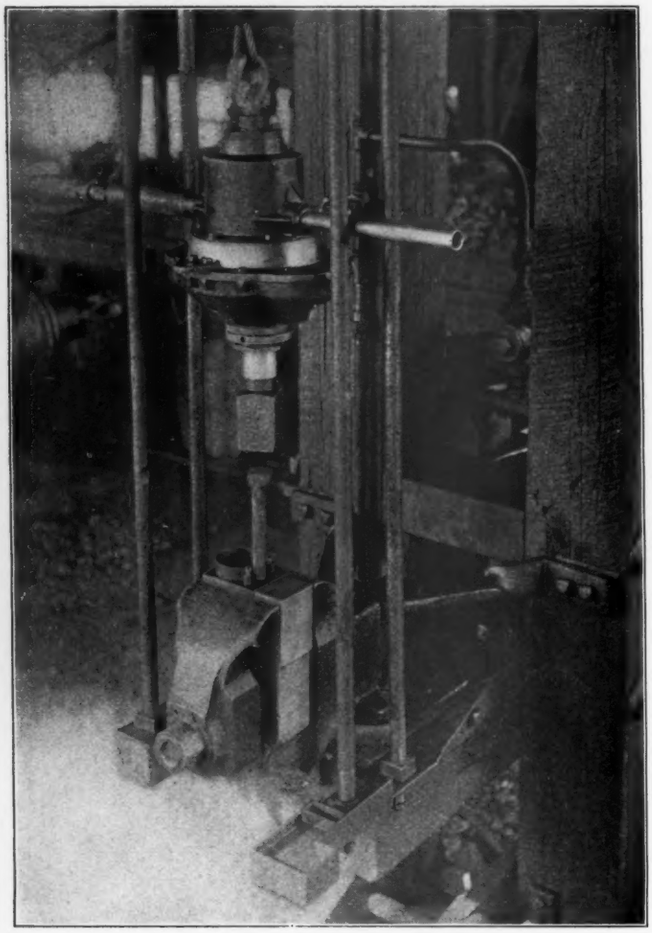


Die Plate and Dies Removed from the Vise

A simple device for reclaiming such bolts without cutting off the ends is shown in the illustration. A die plate or socket is fitted to an ordinary parallel vise from which the screw has been removed, the movable jaw of which is operated by an air cylinder. Dies of different sizes suitable for the bolts to be worked on are fitted to the screw plate, the two halves of each pair being connected by a flat steel spring as shown in one of the illustrations. When air is released from the cylinder and the vise opened the dies are thrown open by the spring and the bolt to be worked on is placed between the dies at the end of the threads next to the head. The air is then applied and the

vise closed. A reversible air motor suspended by means of a pulley and counterweight and provided with a suitable socket is used to unscrew the bolt from the die, thus restoring the threads to serviceable condition. This operation requires much less time than the cutting off and rethreading of the bolts, and since they retain their original length they are suitable for the work to which they were originally applied.

A simple device for restoring the threads on smaller size bolts, such as ⅜ in. and ½ in., consists of a screw plate provided with a crank attachment similar to a carpenter's brace. Dies of the required sizes are provided to fit the screw plate. For rapid work the bolts are held in a vise operated by an air cylinder, the die plate being run over the threads by hand. In this way the threads of small bolts are restored quicker than they could be reclaimed by cutting off and rethreading.



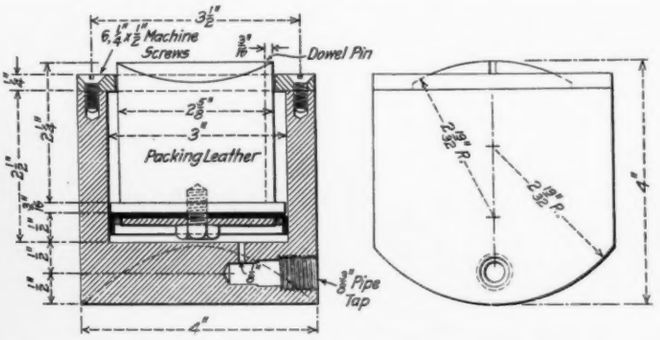
Bolt in Position to Be Threaded Out of the Dies with an Air Motor

REMOVING INDENTATIONS IN SUPERHEATER SMOKE TUBES

BY H. M. BROWN
Shop Superintendent, Chesapeake & Ohio, Huntington, W. Va.

Superheater smoke tubes, because of their large diameter, are very readily injured by rough handling. Indentations are formed in removing and rattling, especially where coke or old arch brick is used in the rattler to assist in removing scale. They not only form obstructions which interfere with the insertion of the superheater elements but also increase the liability of the tubes to collapse under pressure.

A jack for removing indentations from 5⅜ in. tubes is shown in the engraving. After the tubes have been rattled and welded they are carefully inspected for indentations, which are marked with chalk. The air jack, which is attached to a piece of ⅜ in. pipe about 30 ft. long, is placed over each indentation on the outside of the tube and the pipe marked with chalk at the end of the tube. The jack is then inserted in the tube, the chalk marks on the pipe serving as guides for its proper location under the indentations. When properly placed air is applied and by lightly striking the tube with a hammer the indentation is quickly removed and the tube pressed back into perfect shape. This work can be done with great rapidity and the tubes are in perfect condition when returned to service.



Device for Removing Indentations from Superheater Smoke Tubes

HORIZONTAL DRILLING ATTACHMENT FOR A RADIAL DRILL

BY V. T. KROPIDLOWSKI

The horizontal drilling attachment shown in the illustration may be used to good advantage on a radial drill for countersinking holes in the flanges of back tube sheets and many other operations of a similar nature. The body of this device, shown at *A*, may be forged solid from a piece of mild steel, such as an old axle, and the recess for the gears cut out, or it may be made from two pieces of round steel, one end of each being split and drawn out flat to the required dimensions, the flat portions being welded and shaped so that the two bars are at

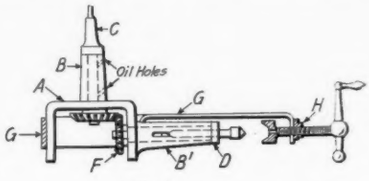


Fig. 1.

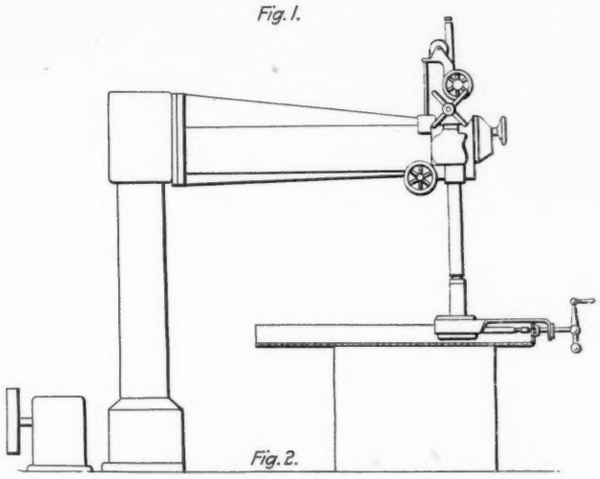


Fig. 2.

Horizontal Drilling Device for Use on Radial Drills

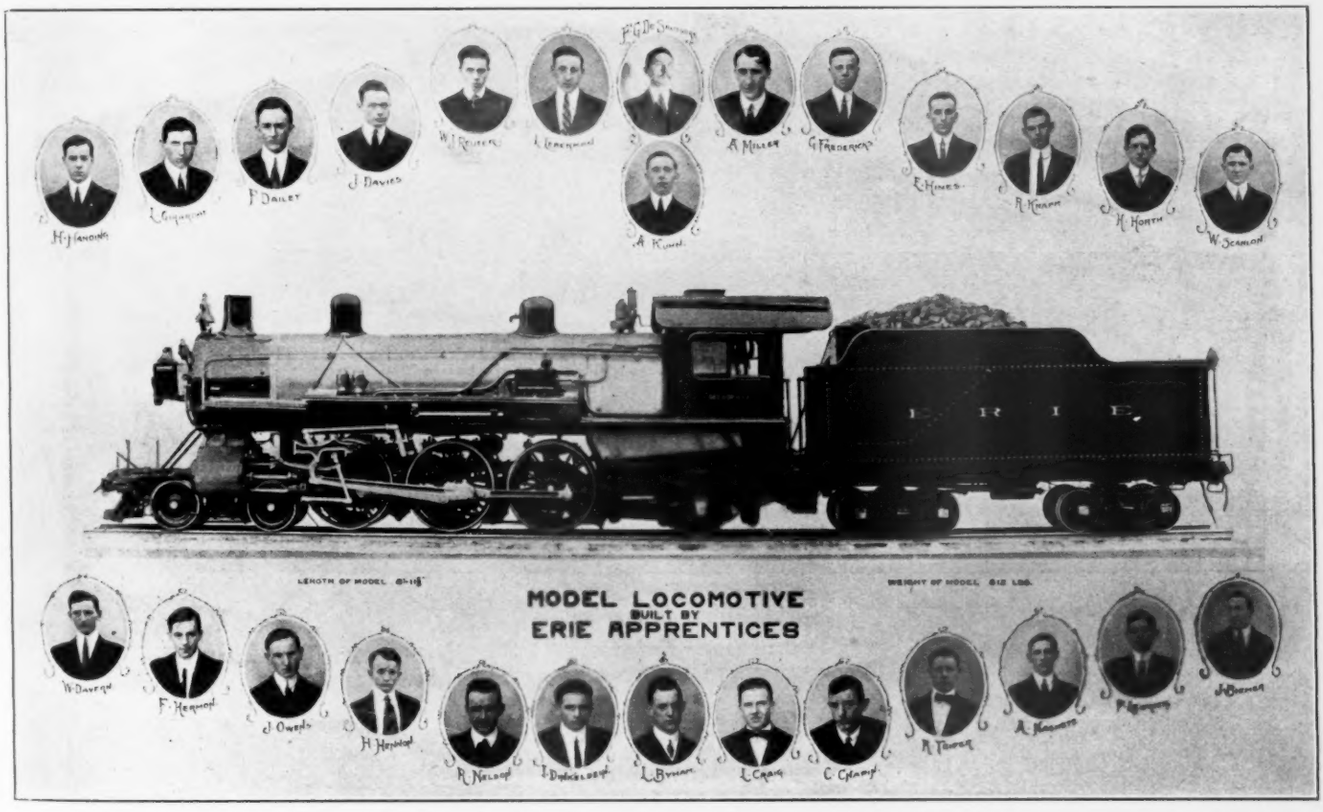
right angles to each other as shown in the drawing. The bars are then finished in a drill press to form the bearings of the spindles *B* and *B*¹. Spindle *B* has a Morse taper extension *C*, for insertion in the drill spindle at one end and a bevel gear at the other. Spindle *B*¹ has a thrust collar *D* on the outer end, which is fitted with a Morse taper socket. The bevel gear on the inner end meshes with the gear on spindle *B*. A yoke *G* of flat merchant iron is bent around the body of the device, the ends being twisted and extended to support a cross piece *H* which carries a feed screw. The work is clamped against the drill by means of the feed screw, the overhang of the horizontal spindle being supported by the work. The illustration shows the device in use for countersinking holes in the flange of a back tube sheet.

MODEL LOCOMOTIVE BUILT BY ERIE APPRENTICES

The apprentices employed in the shops of the Erie Railroad at Meadville, Pa., have designed and built complete a model of a Pacific type passenger locomotive.

Meadville is one of several points on the Erie where apprentice schools are maintained. To test the proficiency of the boys at the Meadville school, the work of building a model engine was entrusted to them, and after eleven months and one day, they completed their task and presented to their master mechanic the miniature engine shown in the accompanying illustration. The locomotive has been named Meadville. The work of building it was begun December 13, 1913, and the engine was completed November 14, 1914. There were 26 apprentices engaged in the work, including one blacksmith, five pattern makers, two boiler makers, one tinsmith and 17 machinists. All drawings were made by the boys and the cylinders were designed by one of them. It took 350 patterns and core boxes to accomplish the work. On a test the engine attained a speed of 572 revolutions per minute. The boiler was tested at 105 lb. per sq. in. hydrostatic pressure. The total weight of the engine, loaded, is 623 lb.; total weight of engine and tender 812 lb.; capacity of tender, coal, 37 lb., water, 11 gal.; boiler pressure 25 lb.; the number of parts in the engine and tender is 4,511.

The work was carried out under the direction of F. G. DeSaussure, instructor of apprentices at the Meadville shops. The model is to be placed on exhibition in the window of the Erie's downtown offices at 399 Broadway, New York.



Group of Erie Railroad Apprentices and Model Locomotive Built by Them

RUNNING REPAIRS*

BY RAILROADER

From statements that appear quite frequently in the magazines it seems that each road has what is considered a fixed charge per locomotive for despatching, and if this charge is exceeded there has to be an explanation made as to the cause. Sometimes it is too much labor at the ash pit, at other times it is due to too much supervision and again it may be brought about by using too high priced labor in handling the engines. In any event, a reduction in forces has to be made. At times extra expenses creep in due to causes beyond control of the shop or terminal management, such as weather conditions, or a falling off of business for a few days, but the reduction has to be made, nevertheless.

Reduction of forces on running repairs should be made only after a careful study as to conditions. As a rule comparisons are made between each month and the preceding one and the same month of the previous year. Sometimes when this comparison is made there is no attention given to the condition of the locomotives at each period. This plays an important part in the running repair charges. If the power was in good condition, inspection cost less and the number of fires drawn was less, due to little if

*Entered in the competition on Engine House Work, which closed July 15, 1914.

any tube trouble; whereas the month with which comparison is made may have required much more work and expense due to the poor condition of the power. As it begins to get run down, engine failures become more frequent and every one is in trouble, a good portion of their time being spent in explaining the cause of failures.

Great care must be exercised in organizing the working force at a terminal, particularly if it is a large one, handling from 100 to 120 locomotives each 24 hours. The main thing to be looked after is the getting of the engines over the ash and inspection pits so as to make room for others. At a terminal of this nature, a few years ago, there were three divisions entering, and passenger trains came in as a rule from each division with only an hour's difference in arrival time. This held out freight trains, and they afterward arrived in groups. The work was successfully handled by the engineers making out their reports clearly and using good judgment in the work they reported. The shop had information through the despatchers as to any delay caused by an engine, consequently, the shop men were prepared to either clean the fire or draw it without any question. It was a rare case when an engine had to be sent back to the pit from the roundhouse to have the fire taken out. The inspectors were on hand at the pit, made a thorough inspection and promptly notified the roundhouse office of all defects. In many cases they did some of the tightening up of loose nuts, applying pins or keys that were missing, etc., but for engines on hard runs they did not do any of this work but reported it to the office with the rest of the work.

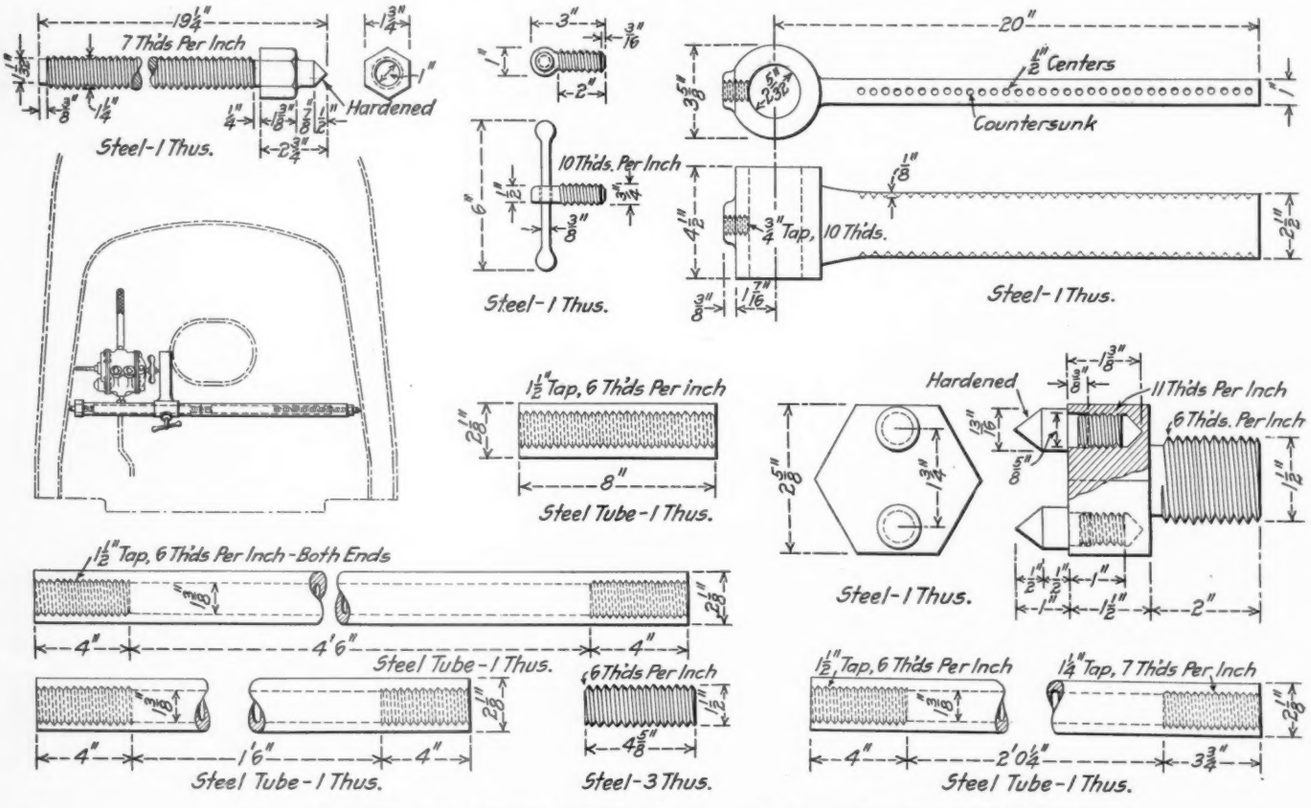
The roundhouse force was so organized that a machinist and helper, or a boilermaker and helper were assigned to particular jobs, which they handled for from two to three months when they would be changed to other work and another set of men took their places. By this method the men got a chance to do all classes of work so that if for any cause a man was absent there was always some one on hand who was acquainted with his work. There was no breaking in of new men on running repairs and therefore less chance for poor work.

Engine house foremen should study their men and their work, place them accordingly and change them at intervals so that there will be no favors shown. Because one man may be good on valve work does not mean that others cannot learn to do the work if given the chance. Try to find out what is in a man; give him a trial and nine times out of ten he will come out all right. This will be encouragement for others to try. A foreman should never call his men to account for mistakes on the floor of the shop within sight and hearing of their fellow workmen; he should never by any act hold up any man to the ridicule of his fellows. If a reprimand has to be given, have the man come to the office, where he can be spoken to and corrected without his losing his self respect.

ADJUSTABLE DRILLING STAND

BY GEORGE E. McCOY

An adjustable drilling stand for firebox work is in use on the Canadian Government Railways, and is the design of an employee of that system at Truro, Nova Scotia. The engraving shows the application of the device to firebox work, and also gives the details. The supporting piece is made up of steel tubing arranged so that it can be adjusted for different lengths according to the position occupied in the firebox. A double center is placed in one end to prevent turning, with an adjustable single center in the other to tighten the stand in place. The drill center is placed against an arm which is held at right angles to the main support of the drilling stand. This is accomplished by means of a boss on the end drilled so that it fits over the steel tubing, and it is then clamped in the desired position by means of a set screw. This arm has center marks placed at convenient distances along its length to provide adjustment for the drill.



Adjustable Drilling Stand Used for Firebox Work on the Canadian Government Railways

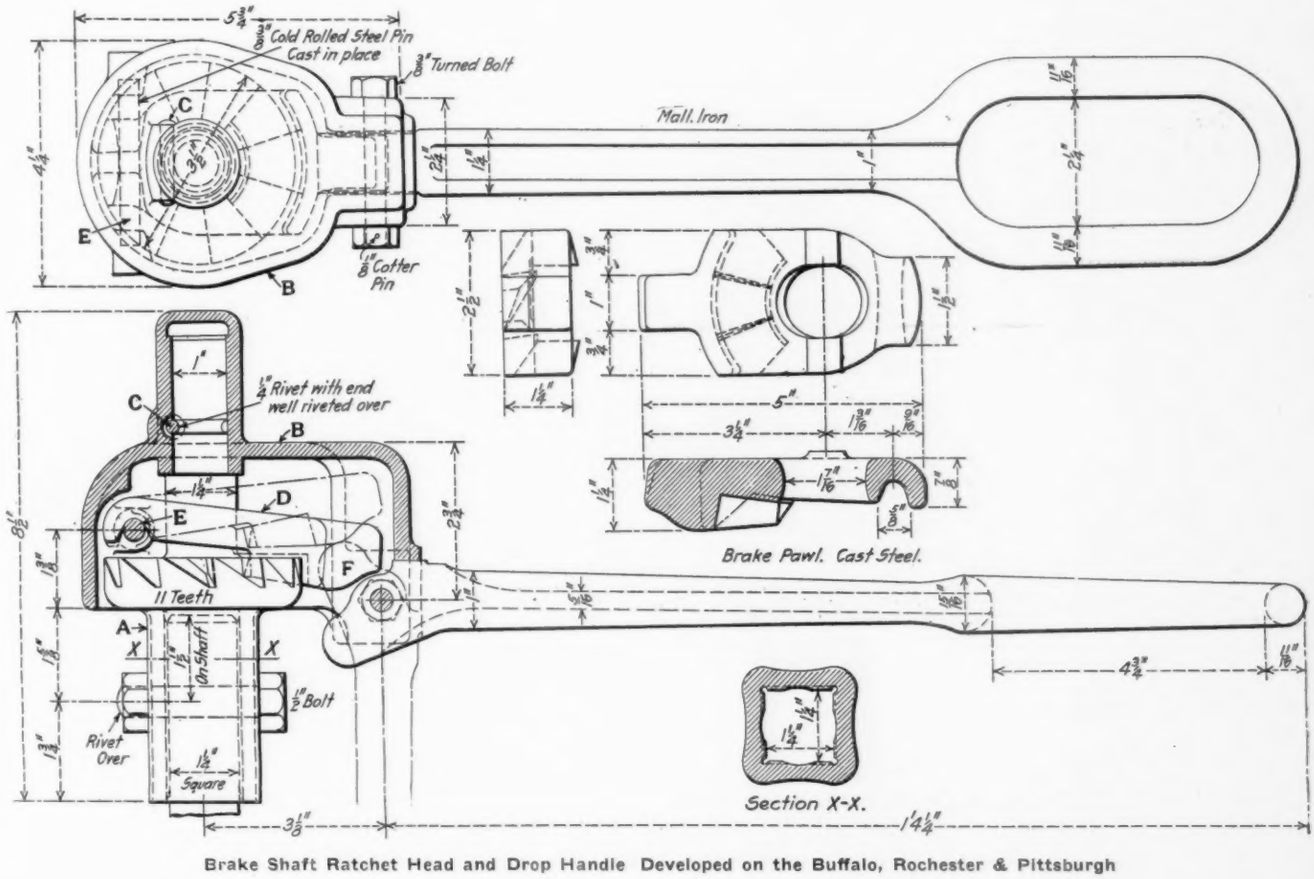
While this device is intended primarily for firebox work it can be readily seen that it is adaptable to many other positions about a locomotive where drilling is necessary.

NEW DEVICES

BRAKE SHAFT DROP HANDLE AND RATCHET

For some classes of cars, such as drop end gondolas and cabooses where a hand wheel is objectionable, or for cars of great carrying capacity where a leverage is desired at the brake shaft greater than that afforded by the standard brake wheel, it is customary to employ a ratchet head with a drop handle instead of the brake wheel. The accompanying illustration shows a device of this kind which has recently been developed on the Buffalo, Rochester & Pittsburgh for application to the square brake shaft* now in service on its equipment.

The drop handle and ratchet head form a complete unit which is interchangeable with the brake wheels used on the pawl are three teeth which are held in engagement with the toothed disc of the ratchet by gravity when the handle is in working position. Projecting from the toothed end of the pawl is a tongue, shown at *F*, which extends into a pocket formed in the housing, just above the jaws between which the drop lever is pivoted. When the lever is in the horizontal position, the pawl engages the teeth on the ratchet wheel, the position of the parts being as shown by the full lines. When the lever moves from working to release position the cam on its upper end makes contact with the lower face of the tongue on the pawl, causing the pawl to rotate upward about the pin *E* to the position shown by broken lines and disengaging it from the ratchet. The cam end of the lever and the tongue of the pawl are so formed that when the lever is swung about halfway from its vertical to its horizontal or working position, the contact ceases and the pawl is fully engaged. The operator is thus



Brake Shaft Ratchet Head and Drop Handle Developed on the Buffalo, Rochester & Pittsburgh

square shafts. The entire device is composed of four castings having a total weight of about 15 lb. The housing and drop handle are malleable iron while cast steel is used for the ratchet and pawl. Referring to the drawing, the ratchet *A* is formed with a socket below the toothed disc and a spindle above the disc. The socket fits the end of the square brake shaft, to which it is secured by a single bolt passing through the shaft; the spindle above the disc serves as a support and bearing for the housing *B*, which may be freely revolved, but is locked against vertical movement by the riveted pin *C*. The pawl *D* surrounds the spindle and is pivoted at one end upon the pin *E*, cast in place in the housing. At the opposite end of the safeguarded should power be exerted against the brake before the lever reaches the horizontal position. The loop form of lever handle protects the operator in case his grip should slip when setting the brakes.

The design of this device is very simple, and it is claimed to have proved its reliability and efficiency in service. Aside from finishing the ratchet spindle and its bearing in the housing, the only machine work required in fitting up the parts is the drilling of a few holes; but little skill is required in assembling and applying it to the brake shaft.

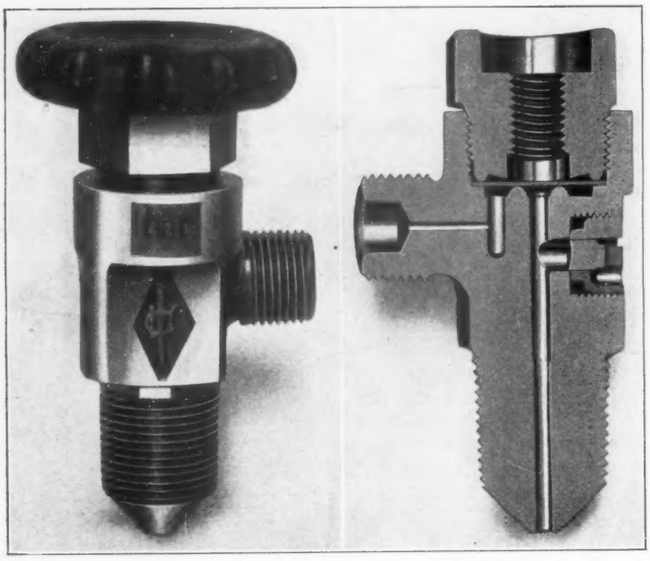
This brake shaft handle was designed and has been patented by F. J. Harrison, superintendent of motive power, and W. J. Knox, mechanical engineer of the Buffalo, Rochester & Pittsburgh.

*For description, see *Railway Age Gazette, Mechanical Edition*, December, 1914, page 647.

A HIGH PRESSURE GAS VALVE

To meet the severe requirements of a satisfactory stud valve for use in high pressure gas cylinders the valve shown in the illustration was developed by the International Oxygen Company, 115 Broadway, New York, for its own use. It has now been tested in service for several years by this company and other gas manufacturers, and is claimed to have proved successful under all conditions.

The valve is designed for use with pressures up to 2,500 lb. per sq. in. and is made of metal throughout. The construction is such that no packing is required in any part, thus eliminating a source of danger when inflammable material is used, as well as a cause of loss from leakage. The body is forged from Tobin bronze, while the other parts are made of metals which are non-corrosive to gases or to weather conditions. The flow of gas is controlled by a diaphragm, as shown in the sectional view of the valve, which is made of a tough, springy material that is claimed to withstand all the strain put upon it without cracking or breaking, even after years of service. The diaphragm takes the place of packing material, and in this way the usual stuffing box is entirely eliminated. It is slightly concave, and normally sets away from the seat of the valve a sufficient distance to permit a full opening without the aid of the gas pressure; this permits all the gas in the cylinder to be used down to atmospheric pressure.



Stud Valve for High Pressure Gas Cylinders

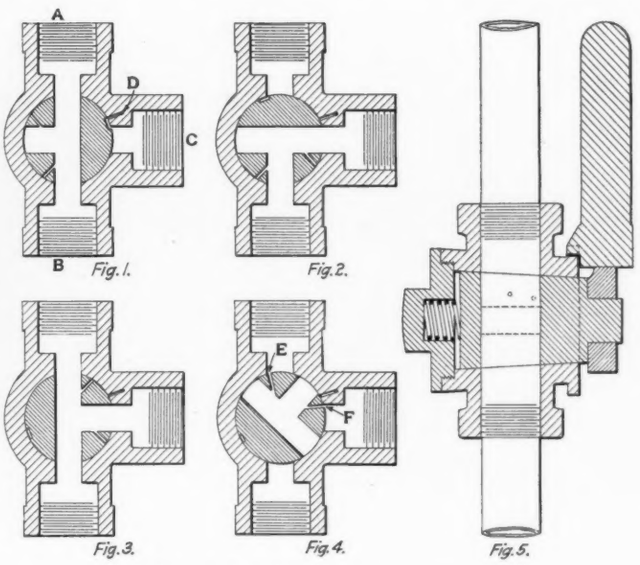
The safety plug used in this valve is designed to meet the requirements of the Bureau of Explosives of the Interstate Commerce Commission. It is filled with fusible metal melting at, or below, the boiling point of water, and is provided with three passages, each in a straight line with the direct action of the gas in the cylinder, to permit the outflow of the metal. The plug has a hemispherical seat which forms a tight joint when screwed into the body of the valve by compressing a phosphor-bronze disc. No part of the plug projects beyond the body of the valve, thus protecting it against breakage. It will not blow when subjected to the direct rays of the sun or to any other atmospheric condition, but the fusible metal will melt and the valve will blow when placed in a fire before the expansion of the gas can do any damage to the cylinder.

The construction of this valve is very simple, and all parts are so arranged that they are readily accessible whenever examination or renewal is required. The hand wheel is so designed that it may be removed or left as a permanent part of the valve.

SAFETY CUT-OUT VALVE

G. H. Wilson, a locomotive engineer on the Atchison, Topeka & Santa Fe, has invented a cut-out valve to replace the ordinary cut-out valve now used in the train line directly under the engineer's valve for the purpose of cutting out this valve when two or more engines are coupled to one train. The special features of the new valve are that it can be used in emergency if there is an accident to the engineer's valve; it is provided with a warning port which gives assurance that there is no train line stoppage between the rear engine and the leading engine as soon as the leading engine is cut in; it permits the rear engineman to instantly assume full control of the brakes in double-heading service, provided he finds it necessary to do so, and lastly, it is so designed that it will not be possible for the helper engine to cut off from the train until the second engineer takes control of the brakes, without the brakes being set throughout the entire train. Its use will eliminate the necessity of having a cut-out cock on the train line leading to the front end of the locomotive.

This valve is in brief a three-way cock with the openings *A* leading to the engineer's valve, *B* to the main train line and *C* to the locomotive train line leading to the front end. Fig. 1 shows this valve in position for operating the train under ordinary conditions. When an extra engine is connected to the front of the train and the air cut in, air escaping through the warning port *D* informs the engineer of the second engine that the engineer of the leading engine is ready to assume control of the brakes. By turning the handle of the valve through one-quarter of a revolution, the valve will assume the position shown in Fig. 2, and thus cut out the engineer's valve of the second engine, giving control of the train to the engineer on the first engine. If the engineer of the second engine desires to assume control of the train he will turn the handle of the valve through another quarter turn, placing the valve in the position shown in Fig. 3, which will place his engineer's valve into operation, controlling the brakes on the leading engine as well as on the train. When it is desired to pick up cars on the head end of the engine it is possible to charge the train line by placing the valve in the position shown in Fig. 4, the openings *E* and *F* charging the train line of this string of cars without disturbing the pressure in the train line of the train itself. After charging the valve is placed in the position shown in Fig. 3.



Safety Cut Out Valve for Locomotives

When a pusher engine is used on the rear of the train these same features obtain with that engine. By the escaping of air

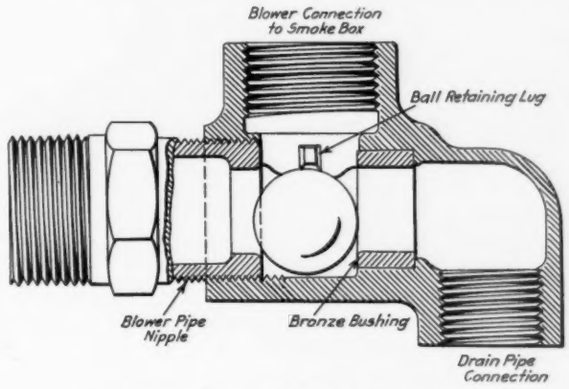
through the warning port *D* the engineer of the rear engine will know that there is no obstructed passage in the train line, and will place his valve in the position shown in Fig. 2, so that the brakes on the helping engine may be operated by the leading engineer. In cases where it is necessary for an engine to haul a train running backwards, the position of this valve will be that shown in Fig. 3, the cut-out cock at the rear of the tender, of course, being closed. Fig. 5 shows cross section through this cut-out valve. Further information regarding this valve may be obtained from Thomas Ogden, Box 252, Rawlins, Wyo.

BLOWER PIPE DRAIN FITTING

Much annoyance is caused to persons standing near a locomotive when the blower is started by the spraying from the stack of dirty water which has accumulated in the blower pipe while the blower valve was closed. Trouble is also experienced from the same cause in cold weather by the freezing of the blower pipe. The blower pipe fitting, a sectional view of which is shown in the engraving, is designed to overcome these conditions by automatically draining the blower pipe at all times when the blower valve is closed.

The device consists of a body of malleable iron in which is inserted a very tough Tobin bronze bushing to form a seat for the ball check. The ball is of gunmetal 1⅛ in. or 1 3/16 in. in diameter, depending upon the size of the fittings, and is carefully ground to form a perfect sphere. The gunmetal mixture is especially adapted to resist the corroding action of steam at high temperatures. The ball may be easily removed by disconnecting the blower pipe nipple and is kept in place by means of the lugs in the smokebox connection.

When not in use the ball is unseated by gravity and all condensation is free to drain from the pipe through the elbow connection from which it may be piped to any convenient point of discharge. As soon as the blower valve is opened steam pressure seats the ball, thus closing the drain port and permitting the entrance of steam to the blower nozzle only. Where fires are started by attaching a hose from the roundhouse steam line to a blower pipe connection on the engine this device is especially useful. In such cases the drain pipe may be arranged for connection to the roundhouse hose and the blower operated merely by opening the valve in the steam line. The pressure in the drain pipe causes the ball to seat against the end of the blower pipe nipple, shutting off connection with the blower pipe and preventing the possibility of the steam backing up in the boiler should the blower valve in the cab be leaky. The use of a valve or plug in the connection for the roundhouse hose is thus made unnecessary.



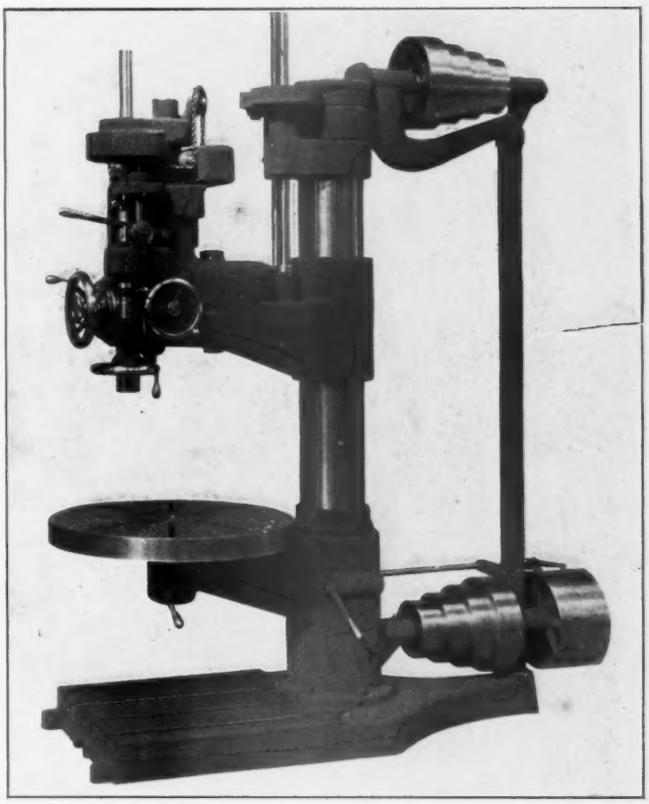
Automatic Drain Valve for Blower Pipe

This device was developed by the Watertown Specialty Company, Watertown, N. Y., and is claimed to have rendered effective service in tests conducted during a period of several months. It is usually made with fittings for 1-in. and 1¼-in. blower pipes, but modifications of the general design of the body can be made to suit special requirements.

RADIAL DRILL

A radial drill in the design of which is incorporated a new type of drill head and arm has been placed upon the market by the Willmarth Tool Works, Cleveland, Ohio. The most prominent feature of this machine is the manner of moving the head and arm for locating the holes to be drilled. The head rotates about a large circular bearing on the arm, and the arm rotates about the column as in the usual type. This produces a double swiveling motion, so that any hole within the capacity of the machine may be easily located. A self-locking spiral gear and rack are provided for moving the head. The bearing of the head on the arm is 17 in. in diameter, and is provided with an annular ring inside for holding it central and a heavy pivot bolt for holding the two together. An eccentric clamp locks the head to the arm.

The column is of the post and sleeve type. The post has a large and heavy lower portion, and extends up to the top member, which is bolted to it, making a braced construction and adding materially to the stiffness. The column sleeve telescopes the post, and has bearings at both the top and bottom, also a large ball thrust bearing at the bottom. The sleeve has a binding clamp at its lower end. The arm is of cylindrical box section, and heavily ribbed on the inside. It is elevated or lowered by means of gears at the top operating a coarse pitch screw hung on ball bearings.



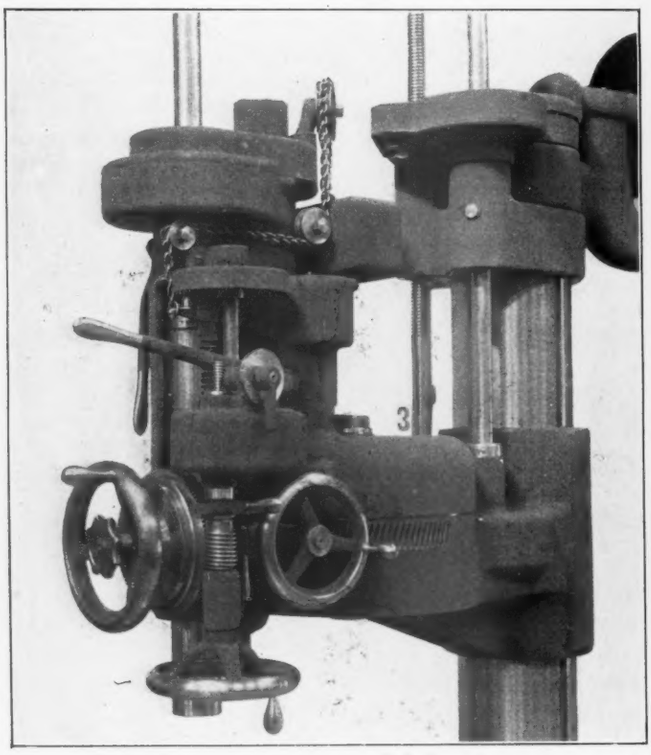
Wilmarth Radial Drill

There are eight changes of speed, from 35 to 375 r.p.m., arranged in geometrical progression. Four changes are obtained by the cone pulleys and four more by the back gearing, which is provided in the spindle driving gears. The tapping mechanism is operated through a jack shaft in the head, running at high

speed, and driving through ring clutches, which are self adjusting. They are operated by means of a lever in front of the machine, enabling the workman to easily start, stop or reverse the spindle.

The spindle is of special steel, and is provided with an ample ball thrust bearing. It has a No. 5 Morse taper socket and is 3¼ in. in diameter at its large end and 1¾ in. at its smallest section. The feeding mechanism is of the selective gear box type. Six changes of feed are provided, ranging from .006 in. to .027 in. per revolution of the spindle. These are instantly available by operating the dial on the front of the feed box. A quick return hand wheel is attached to the feed pinion shaft, and the engagement of the worm to it is made by means of a friction ring controlled by a nut in front of the hand wheel. Both depth gage and automatic trip are incorporated in the feed mechanism.

The bearings throughout are bushed with high grade special bearing bronze, and ample oiling facilities are provided. No cast iron gears are used in this machine. In accordance with their



Rotating Head for Wilmarth Radial Drill

requirements the gears are of steel, bronze or a specially high grade semi-steel. All gears are fully guarded.

The principal dimensions of the machine are as follows:

Range of drilling	48¾ in.
Greatest distance from spindle to base	52½ in.
Greatest distance from spindle to table	27 in.
Vertical traverse of spindle	11¼ in.
Vertical traverse of arm on column	28 in.
Height of machine	96 in.
Weight of machine	3,500 lb.

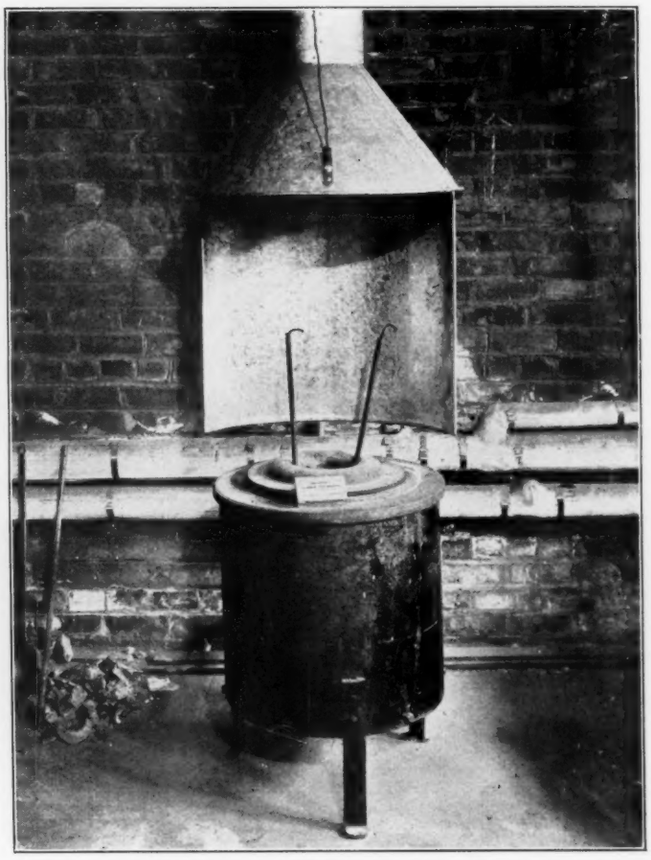
SERVICE TEST OF AUTOMATIC HOSE CONNECTORS.—A service test of the automatic hose connectors manufactured by the Robinson Coupler Company, Washington, D. C., has been in progress on the Canadian Northern since June 10, 1914. The cars equipped are in ore service on a branch line 165 miles long and it is understood that under varying weather conditions the equipment has required no attention for renewals or repairs, tight joints having been maintained with temperatures as low as 35 deg. below zero.

MACHINE RECORDS.—Some method of recording the location and movements of machines is necessary, particularly in large plants and those in which an appraisal is to be kept up to date.—*American Machinist.*

METALLIC SALTS PYROMETERS

A method of measuring high temperatures wherever heat is applied has been developed by the Carl Nehls Alloy Company, Detroit, Mich., and is based upon the melting points of various mixtures of metallic salts. Molecular mixtures of metallic salts are made up which have melting points ranging between 220 deg and 1,330 deg. Centigrade. Practical means have been devised for using these mixtures in place of costly instruments. They are also very useful for checking other pyrometers.

The mixtures are made up in two forms, the solid and the paste. In the solid form they are cast into cylinders, 7/16 in. in diameter and ¾ in. long. Each cylinder is wrapped in paper on which is printed its correct melting temperature in degrees Centigrade. For all temperatures below 500 deg. Centigrade



Method of Temperature Indication in Metal or Salt Bath Furnace

(932 deg. F.) the cylinders, which are known as Sentinel pyrometers, may be used in air-tight glass tubes, especially provided for that purpose. The same cylinder may thus be used repeatedly. For other purposes where the use of the tubes is not practicable small porcelain saucers are provided which prevent the wasting of the salts and the littering up the place where they are used. This also enables the same salts to be used several times before renewal is necessary.

In the paste form the mixtures are packed in tins, each of which contains enough to make several hundred determinations. The temperature at which furnaces, ovens, retorts, steam pipes, etc., are operating may be determined by placing a steel bar on which a small amount of the various pastes has been daubed, in the furnace or against the part. The temperature will be between the melting points of the last paste to melt down and the one having the next higher melting point. By using a long bar one can determine whether the temperature is uniform in the front and back, top and bottom, or the corners of a furnace, oven or kiln.

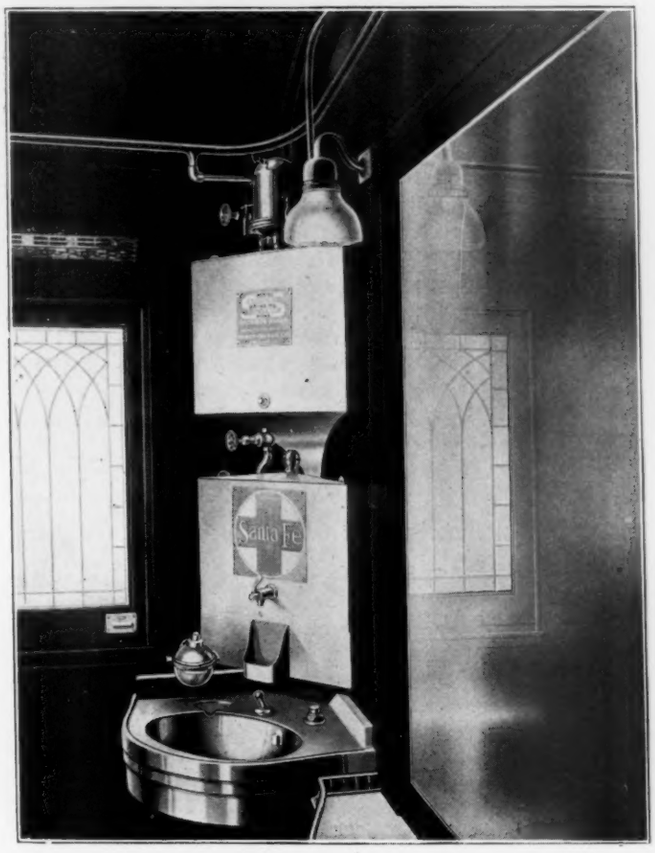
This method of determining temperatures is especially useful

in connection with the hardening of tools in a forge fire. A paste is selected that represents the correct hardening temperature for the tool and a small amount daubed on the tool. The melting of the paste clearly indicates the time when the tool can be taken out of the fire and quenched. Surrounding the tool with a piece of sheet steel or inserting it in a piece of gas pipe will add to the accuracy of the results by keeping the paste from coming in contact with the fuel.

A method of using the Sentinel cylinders is shown in the illustration. Two tubes or pipes with plugs in the bottom ends are placed in the furnace. Sentinel cylinders from different melting temperatures are dropped into the tubes and metal rods are stood on top of the cylinders. When the cylinders melt the rods will drop to the bottom of the tubes. When one rod is lowered and the other is not the temperature is between the melting points of the two cylinders. These need be only 10 degrees apart. This is very useful for finding the temperature of molten metals, salt bath furnaces, etc.

SANITARY DRINKING FOUNTAIN FOR PASSENGER CARS

A combined drinking fountain filter for passenger cars has been brought out by Henry Giessel & Co., Chicago, and has been giving good results in service on one of the western roads. It is known as the "North Pole" sanitary drinking fountain, and is made up of a filter, a storage tank for the filtered water, a cooling pan and an ice box. The fountain occupies a space 14 in. by 17 in. by 48 in., and all parts are accessible for inspection. Water from an overhead tank flows to the filter at the top of the fountain and is filtered through Tripoli rock, then passing to the storage tank directly below. From this tank it passes to the cooling pan in the ice box, which is a small vessel of watertight construction. The ice surrounding the cooling pan lowers the temperature of the drinking water to a desirable degree without permitting any of the ice water to mix with the drinking water.



Sanitary Drinking Fountain Applied to a Passenger Car

The metals used in the construction of the fountain are non-corrosive throughout. The filter case is made of galvanized malleable iron and heavy tinned sheet brass. The storage tank and cooler are made of heavy galvanized iron sheets. The cooling pan is made of galvanized gray iron. All the pipes and fittings are also galvanized and the parts exposed to view are finished in German silver. The filter is in the shape of a cylinder with its core removed; the water seeps through from the outside to the inside and passes directly to the storage tank. The filter material does not absorb the impurities of the water, and may readily be cleaned by scrubbing in water with a stiff brush. It may be removed and cleaned in about five minutes and should be cleaned every few days.

Aside from its sanitary characteristics, the principal features of this drinking fountain are the cheap grade and small quantity of ice that may be used. Comparative tests between this and an ordinary water cooler in passenger cars between Chicago and Kansas City showed a saving of 73.6 per cent in the amount of ice used and 80 per cent in the cost of the ice in favor of the sanitary fountain, the temperature of the drinking water averaging 49 deg. for the sanitary fountain and 38 deg. for the ordinary water cooler. Less care is required in the maintenance of this cooler than of the ordinary cooler, a general cleaning being necessary only when the cars are shopped. Provision is made for draining the entire system when the car is out of service and without heat in cold weather.

CHASER GRINDER

A machine for grinding thread cutting dies, especially designed to meet the requirements of users of dies made by the Landis Machine Company, Waynesboro, Pa., has recently been brought out by that company. The machine is of a duplex nature, one side being fitted with an attachment for handling all sizes of Landis chasers and the other with a device to sharpen the disc cutters of roller pipe cutting machines. It may also be used to grind tools, for lathes, planers, shapers, etc.

Chaser Grinder and Disc Sharpener for the Cutters of Roller Pipe Cutting Machines

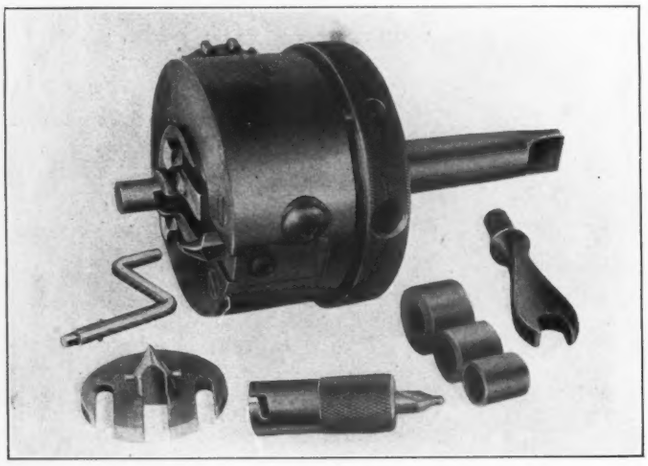
The chaser grinding attachment has adjustment in both hori-

zontal and vertical planes with suitable graduations for controlling the lead and rake angles of the dies. Both the transverse and longitudinal feeds are in horizontal planes, a feature which insures accurate grinding. The table is gibbed at both slides and furnished with an overhang to protect the guides from emery dust. The disc cutter grinding attachment is operated by hand and has both vertical and horizontal adjustments. An adjustable rest is also provided to facilitate the handling of miscellaneous tools.

AUTOMATIC FACING TOOL

The facing of bosses and other similar work with the ordinary flat spot facing tool has always been a troublesome operation owing to the difficulty of getting the tool properly started into the work. The cutting edge of the tool is usually ruined in scraping off the scale so that it must be either reground or replaced by a sharp tool before the operation can be completed. A facing tool designed to overcome these difficulties has recently been introduced by the Mummert-Dixon Company, Hanover, Pa. This tool is provided with a Morse taper shank and is readily applied to a drilling machine spindle whenever work of this kind is to be done.

By referring to the illustration it will be seen that the tool takes an ordinary lathe tool bit, which has a radial movement from the center outward controlled by means of a feed screw. The operation is therefore the same as facing on a lathe. The tool gets beneath the scale at the start and breaks it away as it is fed across the work. The feed is effected by means of the



Facing Tool for Drill or Milling Machine

knurled ring on the upper face of the tool, which is either gripped with the hand or held by means of a pin inserted in one of the holes in the knurled edge, and placed against the frame of the machine. The pilot fixture attached to the bottom face of the tool is designed to enter the hole in the center of the boss and steady the tool. Thimbles of various sizes may be placed on the pilot spindle in order that it may be used in holes of any size. In case there is no hole in the boss when the facing is done the cone center and drill pilot may be used. After the work has been centered the drill attachment is removed and the tool steadied by means of the cone center. When the tool is used on a boring mill or other machines with rigid spindles, the use of either guide is unnecessary.

This tool is claimed to increase the rapidity with which work of this kind may be done. The tool bit may be readily removed for sharpening and replaced by another with no more trouble than is required to remove the bit from an ordinary lathe tool. The Morse taper shank is furnished in three standard sizes to fit any drill spindle. The tool is made in 4-in. and 6-in sizes, indicating the maximum diameter which it will face.

EYE PROTECTORS FOR MACHINISTS AND GRINDERS

A goggle especially designed to meet the requirements of machinists and grinders has recently been placed on the market by T. A. Willson & Co., Inc., Reading, Pa., in the construction of which considerable attention has been given to comfort as well as to eye protection. By the use of a special frame design, the weight is made very light without sacrificing the ability to withstand rough usage in the shop. An adjustable bridge enables the wearer to easily fit the goggles to his face. This bridge is pliable, strong and securely attached to the eye wire. The bridge does not touch the top of the nose at all, but the weight of the glasses is distributed over the sides of the nose and cheeks. This construction makes it possible for the goggles to be worn over other glasses.

It is of the greatest importance that grinders and machinists be protected from emery dust and grit which whirl around the sides of glasses. The light fine-mesh wire sides of these goggles, it is claimed, give complete protection at the sides without being uncomfortable to the wearer. Comfort is further assured by the flexible half cable temples, which easily conform to any face and do not pull or cut into the ears. A fine quality glass is used to insure freedom from eye strain, and lenses may be easily and quickly replaced by simply loosening one of the screws of the end-piece. Being made entirely of rust-proof metal, the goggle is perfectly sanitary and can be thoroughly sterilized at any time.

Several types of goggles are included in the line being placed on the market by this company, each designed to meet the requirements of a certain class of service. For chipping, a frame is used which is especially adapted to prevent glass flying inward should a lens be broken.

STRENGTH OF BALL BEARINGS.—In an accident due to high water the car lighting dynamo of a Santa Fe combination coach and mail car was badly damaged, the armature shaft, which was 1½ in. forged steel, being bent and the dynamo pulley entirely broken up. The dynamo was a Bliss type O, equipped with two No. 412 S. K. F. ball bearings. The dynamo suspension and the generator frame were both badly sprung, the latter being sufficiently out of round so that two of the pole faces bound on the armature. The armature itself was not injured, but the force which caused the bending of the shaft was great enough to break up both the end housings which enclose the bearings. The bearings themselves, which acted as fulcrums, over which the shaft was bent, were entirely uninjured and will be returned to service without any repairs.

BRONZE JOURNAL BEARING.—The American Metal Company, Pittsburgh, Pa., has recent tested a 22-lb. bronze journal bearing placed under the tender of a Pacific type locomotive on the Baltimore & Ohio. This engine ran 51,000 miles with only 1/32 in. wear of the bearing, while the other bearings on the tender were rebabbitted six times each. The composition of these bearings is 65 per cent copper, 30 per cent lead and 5 per cent tin; they are heat treated in crucibles and are solid bronze castings, requiring no babbitt surface. An extreme test of this metal was made under a rolling table of a 108 in. plate mill at the Jones, Laughlin Steel Company's plant at Pittsburgh. The minimum weight on these bearings was estimated at 10,000 lb. Two 75-lb. brasses gave continuous service for four weeks, or twice as long as the ordinary phosphor bronze bearing, and on account of the position of the bearings it was impossible to lubricate them during the test. The graphite in the lead acts as a lubricant and thus reduces the amount of lubricant required.

GRINDING WHEELS.—In many cases, as a grinding wheel wears down the speed of the wheel is allowed to diminish. When this is the case the grain depth of cut will be increased on account of the diminished wheel speed, as well as because of the smaller wheel.—*American Machinist.*

NEWS DEPARTMENT

The large roundhouse of the Duluth, Winnipeg & Pacific at Duluth, Minn., was destroyed by fire December 25. Several locomotives were damaged.

The shops of the St. Louis, Iron Mountain & Southern at Argenta, Ark., which were closed recently were reopened on December 1, 1914, putting 600 men back at work.

The Baltimore & Ohio Chicago terminal repair shop at East Chicago, Ind., was seriously damaged by fire recently. Some damage was also done to the cars in the shop.

The Southern Pacific Co. issued an order effective December 21, 1914, calling back to work 1,600 men who were laid off at the Los Angeles shops during the latter part of October.

The safety supervisor of the El Paso & Southwestern announces that the number of employees injured during the month of October, 1914, was less than half the number reported in October, 1913.

President Kenly, of the Atlantic Coast Line, announces that reductions of from 6 per cent to 10 per cent have been made in the salaries of all persons in the employ of the company receiving $200 or more a month.

Forty or more railroad employees arrested recently at Pinner's Point (Norfolk) Va., for working at the freight station on Sunday, were fined five dollars apiece. The Southern Railway, acting in behalf of its employees, appealed the case to the Norfolk County Circuit Court.

The safety and efficiency bureau of the San Pedro, Los Angeles & Salt Lake reports a reduction of 33.9 per cent in the number of injuries to employees for the year ending October 31, 1914, as compared with the preceding year. Three employees were killed, the lowest record in the history of the road, except that for 1909, when three were killed.

The new car shops for the Chicago & Eastern Illinois at Oak Lawn, near Danville, Ill., adjoining the locomotive repair shops, were completed December 1, and the new building was put into use at once. At the same time the old shops, which had been closed for some time, resumed operations with a full force working 40 hours a week.

In the yard of the Boston & Maine at Somerville (Boston) Mass., about 2 o'clock in the morning of December 17 last, the police took into custody 118 tramps, who were found in passenger cars, where they had expected to spend the night in the comfortable atmosphere of the cars, which were being kept warm for use early the next morning. On being searched at the police station, not a cent of money was found among the whole crowd.

The Bureau of Mines, of the Interior Department, has eight mine-rescue cars traveling through the different mining districts, giving instructions to miners in rescue, first aid and safety methods. The bureau also has five mine-rescue stations in different coal fields from which it is carrying on similar work. Legislation now pending in Congress will, if enacted, provide for continuous operation of cars throughout the year. Most of the railroads haul the cars free.

At the evening session of the annual meeting of the American Society of Mechanical Engineers in New York, December 2, 1914, the John Fritz Medal was awarded to Prof. John E. Sweet, honorary member and past president of the society, "for his achievements in machine design and for his pioneer work in applying sound engineering principles to the construction of the high speed steam engine." This medal is awarded by the four national engineering societies.

Work was resumed on December 1, 1914, at the shops of the Wheeling & Lake Erie at Brewster, Ohio, and Ironville, in compliance with an order by Judge John H. Clarke, of Cleveland, to the receiver of the railroad. The shops had been practically idle for two months and repairs to cars had been reduced for reasons of economy in order to meet certain interest payments. This policy the court criticized, as neither wise from an economical standpoint nor just from a social point of view.

Although it was reported recently that the members of the shop craft unions had voted to call off the strike which was declared in September, 1911, on the Illinois Central and the Harriman lines, announcement has since been made by the railway department of the American Federation of Labor that the boilermakers voted in favor of calling off the strike, but that their vote was not large enough to offset the vote of the machinists, blacksmiths, car men and sheet metal workers.

The Brotherhood of Railroad Trainmen has filed a statement with the Missouri recorder showing that a total of $16,056 was expended in the campaign for the passage of the full crew bill, which was defeated by referendum vote at the election on November 3, 1914. The Missouri Legislative Committee of the brotherhood, according to the statement, collected $15,880, leaving a deficit of $176. It is stated that the members of the Brotherhood of Railroad Trainmen contributed $14,680 and that $1,200 was contributed by the Order of Railway Conductors.

Mr. Love, chairman of the Oklahoma Corporation Commission, is reported as proposing to ask each high school and higher educational institution of the state to offer, as a part of its course of study, instruction in the making and adjustment of freight rates. He wants to give the next generation in Oklahoma a general knowledge of railroad rates, their application and adjustment, which, he says, are all Greek to the average citizen. Mr. Love must be of an optimistic temperament. If he really wishes success he should begin by giving the boys a couple of years of real Greek, as a preliminary training.

The Baltimore & Ohio recently sent four superintendents on a trip of inspection to the Pacific coast, to be gone ten days; and on the return of the party, four other superintendents will be sent on a similar journey but by a different route. The men going on the first trip are H. B. Voorhees, G. D. Brooke, J. C. Hagerty and E. W. Scheer; and those on the second trip, R. N. Begien, F. B. Mitchell, E. T. White and M. V. Hynes. It is expected that all the general and division superintendents of the company will make trips of this kind, occasion being taken to send them now while business is below normal.

The executive committee of the Chicago Association of Commerce has adopted a resolution in favor of setting the clocks throughout the nation ahead one hour in order to secure more daylight after working hours in the summer months. The resolution also asked the United States Chamber of Commerce to consider the question at its annual meeting in February, in Washington, with the idea of bringing about a nation-wide movement in favor of the change. A special committee of the association held a meeting last week to consider a plan for adopting Eastern time for Chicago in-

stead of Central, but so much opposition was expressed by railroad men present, on account of the confusion which would result if Chicago made the change, that it was decided to push the movement along national lines.

The Nashville, Chattanooga & St. Louis has recently placed orders for additional machinery to be used in the equipment and enlargement of its shops at Nashville so that 1,000 freight cars may be built by the company annually. The impelling motive in this decision on the part of president John Howe Peyton and general manager D. B. Carson was not alone the economy, but in order that employment might be given to some of the old and efficient employees of the company and that the unemployed in this section might have an opportunity to secure work. It is estimated that between 400 and 500 additional men will be used in the car-building department of the road and that work will begin early this year. The new equipment necessary will cost $30,000 and the shops will eb rearranged and thoroughly modernized.

The House Committee, at Washington, has reported the Post office appropriation bill for the next fiscal year, with a rider in which are embodied the provisions of the Moon bill for changing the basis of railway mail pay; and Mr. Peters, the chairman of the Railways' Committee, says that an attempt is being made to secure from the Rules Committee a rule to facilitate the passage of the proposed new legislation. Mr. Peters reiterates his declaration that the provision of the Moon bill for payment to the railways on the basis of space occupied is not only unfair in principle, but embodies rates per mile very much too low. With the space in a car fully loaded, the compensation would amount in many cases, to less per ton per mile than ordinary rates for the transportation of coarse commodities by freight train. The railroads are now losing not less than eight millions annually because of the parcel post, and if the space rates are adopted this loss will be still greater. The small railroads, which are now the worst sufferers from inequitable rates, would lose from 25 per cent to 65 per cent additional if the plan should be adopted.

CORRECTION

In the article in the December, 1914, issue, page 614, describing the Chesapeake & Ohio Pacific type locomotives, reference was omitted, through an accident, to the fact that the locomotives are equipped with the type C Street stoker manufactured by the Locomotive Stoker Company, Schenectady, N. Y.

INTERNATIONAL RAILWAY CONGRESS POSTPONED

Word has been received from Berlin that because of the war all preparations have been broken off for the ninth session of the International Railway Congress, which was to have been held there next June. The congress, whose membership consists of governments and companies operating more than half of the earth's railway mileage, is perhaps the most important railroad association in the world. Its sessions are held every five years, the last having occurred at Berne, Switzerland, in 1910. They are devoted to the discussion and interchange of ideas on questions of railway maintenance, equipment and operation. The German government was to have acted as host, and it was understood that Kaiser Wilhelm would have opened the convention. Some of the American "reporters" have already prepared their papers for the congress.

SUPPLYMEN'S GIFTS DISAPPROVED

President Ripley, of the Atchison, Topeka & Santa Fe, published in the December issue of the Santa Fe Magazine the following letter addressed to all employees:

"Most individuals and companies dealing in railroad supplies have given up the practice of sending Christmas presents to railroad employees and officials. However, to a certain extent the practice was in evidence last year. I have always been opposed to this practice, have discouraged it, and am glad that it is decreasing. I want Santa Fe men to take such action as seems proper to eliminate it entirely. I appreciate that many of the presents given are tokens of friendship extending over many years; nevertheless the practice is bad, and certainly so where the presents have any value. The high standing enjoyed by Santa Fe men makes it all the more desirable that the practice cease."

RESEARCH FELLOWSHIPS AT UNIVERSITY OF ILLINOIS

The engineering experiment station of the University of Illinois announces that four vacancies will be filled at the close of the current academic year in the research fellowships, ten of which have been maintained since 1907. These fellowships, each of which carries an annual stipend of $500, are open to graduates of approved universities and technical schools, appointment being made for two consecutive collegiate years. Not more than half the time of a research fellow is required for the work to which he is assigned, the remainder being available for graduate study, and at the end of the two years, if all requirements have been met, the master's degree is granted. The subjects covered in this research work include architecture, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering and theoretical and applied mechanics. Nominations to these fellowships are based on character, scholastic attainment and promise of success, preference being given to applicants who have had some practical engineering experience since completing their undergraduate work. Applications for nomination must be received by the Director, Engineering Experiment Station, University of Illinois, Urbana, Ill., not later than February 1.

MEETINGS AND CONVENTIONS

International Railway General Foremen's Association.—At a recent meeting of the executive committee of the International Railway General Foremen's Association, it was decided to hold the 1915 convention at Hotel Sherman, Chicago, July 13-16, inclusive.

International Engineering Congress.—Some confusion seems to have arisen between the International Electrical Congress, which it was proposed to hold in San Francisco in September, 1915, and the International Engineering Congress, which, as

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Jan. 12	Preventing Damage to Freight	Various authors	James Powell	St. Lambert, Que.
Central	Jan. 8	Electric Railway Night		Harry D. Vought.	95 Liberty St., New York.
New England	Jan. 12	Making Friends	R. V. Wright	Wm. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Jan. 15	Practical Methods of Tonnage Rating	J. M. Daly	Harry D. Vought.	95 Liberty St., New York.
Pittsburgh	Jan. 23	Prime Movers	H. P. Herr	J. B. Anderson	207 Penn. Station, Pittsburgh, Pa.
Richmond	Jan. 11	General Electric Electric Cars	J. F. Layng	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	Jan. 8			B. W. Frauenthal	Union Station, St. Louis, Mo.
South'n & S'w'rn.	Jan. 21	Electric Welding		A. J. Merrill	218 Grand Bldg., Atlanta, Ga.
Western	Jan. 19	Economies in Freight Car Repairs	H. H. Harvey	Jos. W. Taylor	1112 Karpen Bldg., Chicago, Ill.

previously announced in these columns, is to be held during the same month. Owing to the unfortunate situation existing abroad, it has been decided by the governing body of the American Institute of Electrical Engineers to indefinitely postpone the holding of the Electrical Congress. This does not affect the International Engineering Congress, which is to be held as originally planned.

American Society of Mechanical Engineers.—At the annual meeting of the American Society of Mechanical Engineers, held in New York, December 1-4, John A. Brashear, Pittsburgh, Pa., was elected president, and Henry Hess, of Philadelphia, Pa., George W. Dickie, New York Shipbuilding Company, Camden, N. J., and James E. Sague, Poughkeepsie, N. Y., were elected vice-presidents. Charles T. Main, Winchester, Mass., Spencer Miller, The Lidgerwood Manufacturing Company, New York, and Max Toltz, St. Paul, Minn., were elected managers. Morris L. Cooke, Philadelphia, was elected manager to fill an unexpired term, and William H. Wiley was elected treasurer.

American Society of Mechanical Engineers.—The second meeting of the season of 1914-15 of the Chicago Section of the American Society of Mechanical Engineers will be held in the La Salle Hotel, Chicago, January 8, 1915. The following papers will be presented:—Locomotive Superheaters, by R. M. Ostermann, assistant to the vice-president, Locomotive Superheater Company; Locomotive Stokers, by Clement F. Street, vice-president, Locomotive Stoker Company, and Railway Economics, by Willard A. Smith, president, Railway Review. The first two papers will be discussed by Robert Quayle, general superintendent of motive power and car departments, Chicago & North Western; H. T. Bentley, superintendent of motive power, Chicago & North Western; D. F. Crawford, general superintendent of motive power, Pennsylvania Lines West, and Dr. W. F. M. Goss, past-president of the society and chief engineer of the Chicago Association of Commerce Committee on Smoke Abatement and Electrification. The last paper will be discussed by H. H. Vaughan, assistant to the vice-president, Canadian Pacific, and W. H. Marshall, president, American Locomotive Company.

All members of the Western Railway Club are invited to attend and all persons desiring to attend the dinner at 6.30 p. m. should notify the secretary, H. M. Montgomery, 316 Home Insurance building, Chicago, immediately. Those wishing to attend the reading of the papers only will be admitted at 8 p. m. The dinner will be served at $1.50 per person.

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass. Convention, May 5-7, 1915, Hotel Sherman, Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen building, Chicago. Convention, June 9-11, 1915, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois Central, Chicago. Convention, July 1915, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North Fiftieth Court, Chicago; 2d Monday in month, except July and August, Lytton building, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—S. Skidmore, 946 Richmond street, Cincinnati, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. G. Hall, 922 McCormick building, Chicago. Convention, May 17-20, 1915, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, July 13-16, 1915, Hotel Sherman, Chicago.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 17, 1915, Philadelphia, Pa.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty street, New York. Convention, May 26-28, 1915, Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen building, Chicago. Convention, June 14-16, 1915, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC. OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September, 14-17, 1915, Detroit, Mich.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. Frankenberger, 623 Brisbane building, Buffalo, N. Y. Meetings monthly.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 17-19, 1915, Hotel Sherman, Chicago.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. & H. R., East Buffalo, N. Y. Convention, September 1915, Chicago, Ill.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

T. U. BROWN has been appointed supervisor of locomotive operation on the lines north and west of Columbia of the Seaboard Air Line, with headquarters at Hamlet, N. C.

W. GILLESPIE, master car builder of the Central Vermont at St. Albans, Vt., has been appointed mechanical superintendent in charge of motive power and car departments, and the position of master car builder has been abolished.

H. C. OVIATT, whose appointment as assistant mechanical superintendent of the New York, New Haven & Hartford, in charge of the newly established bureau of fuel economy, with headquarters at New Haven, Conn., has already been announced in these columns, was born on December 5, 1871, at Milford, Conn., and was educated in the grammar school of his native town. He began railway work on May 23, 1889, as a locomotive fireman on the New York, New Haven & Hartford. In July, 1894, he was promoted to locomotive engineman, and in February, 1900, was appointed air brake inspector. Three years later, he was appointed foreman of engines, and in August, 1904, was promoted to master mechanic on the same road. He subsequently served as general inspector of the mechanical department, and in May, 1913, was appointed assistant mechanical superintendent. The following September, he was appointed superintendent of the Old Colony division, which position he held until November 9, 1914, when he was appointed to his present position.

H. C. Oviatt

C. H. SEABROOK, superintendent of machinery of the International & Great Northern, with headquarters at Palestine, Tex., has resigned, effective January 1.

IRWIN A. SEIDERS has been appointed fuel inspector, a position recently created by the Philadelphia & Reading, with headquarters at Reading, Pa. Mr. Seiders has been continuously in the service of the Philadelphia & Reading for 33 years, having entered the Tamaqua shops as a laborer early in the year 1882. He served in various capacities in the shop, station and train service until September, 1888, when he entered the engine service as fireman. He was made road foreman of engines in April, 1907, in which capacity he served until his recent appointment as fuel inspector.

S. S. STIFFEY has resigned as superintendent of motive power of the Toledo & Ohio Central and the Zanesville & Western, and that office has been abolished.

T. A. SUMMERSKILL, superintendent of motive power of the Central Vermont at St. Albans, Vt., has been assigned to other duties and the office of superintendent of motive power has been abolished.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

N. M. BARKER has been appointed master mechanic in charge of locomotive, car and supply departments of the Copper Range Railroad, at Houghton, Mich., succeeding John A. Berg, assigned to other duties.

J. R. BISSETT has been appointed road foreman of engines of the South Carolina division of the Seaboard Air Line at Savannah, Ga., and the River Junction Line, formerly under the supervision of the road foreman of engines of the Florida division, is now under the supervision of Mr. Bissett.

J. A. CASSADY, master mechanic of the Alabama Great Southern at Birmingham, Ala., has been appointed master mechanic of the Cincinnati, New Orleans & Texas Pacific, at Somerset, Ky., succeeding H. B. Hayes.

J. J. CLARK, formerly general foreman of the Missouri, Kansas & Texas at Walnut Springs, has been made master mechanic at Waco, Texas.

H. CRAMER, road foreman of engines of the Seaboard Air Line at Savannah, Ga., has been appointed supervisor of locomotive operation of the lines south of Columbia, with headquarters at Jacksonville, Fla.

J. E. FITZSIMONS, master mechanic of the Central Vermont at St. Albans, has been assigned to other duties and the position of master mechanic has been abolished.

A. HALLMAN has been made road foreman of engines of the Missouri, Kansas & Texas at Smithville, Tex., succeeding C. E. Stanton.

A. E. HAMLET, road foreman of engines of the North Carolina division of the Seaboard Air Line at Hamlet, N. C., has been transferred to the Alabama division in the same capacity, with headquarters at Americus, Ga.

G. W. HENRY has been appointed assistant road foreman of engines of the Cleveland division of the Baltimore & Ohio at Cleveland, Ohio

D. W. HIGGINS has been appointed road foreman of engines of the Rock Island Lines at Fairbury, Neb., succeeding W. D. Oakford.

E. J. LANGHURST, assistant road foreman of engines of the New Castle division of the Baltimore & Ohio, has been appointed road foreman of engines at Parkersburg, W. Va.

E. H. MCCANN has been appointed master mechanic of the San Antonio, Uvalde & Gulf, with headquarters at Pleasanton, Tex., succeeding J. H. Ruxton, resigned, whose title was superintendent of motive power.

WILLIAM MCELRATH has been appointed road foreman of engines of the Rock Island Lines at Eldon, Mo., succeeding J. H. Wood.

W. W. PAYNE has been appointed road foreman of engines of the North Carolina division of the Seaboard Air Line, at Hamlet, N. C.

CAR DEPARTMENT

A. D. BRICE, assistant to the master car builder of the San Antonio & Aransas Pass, has been appointed master car builder, with headquarters at Yoakum, Tex., succeeding W. T. Cousley, resigned.

WILLIS C. DEMPSTER has been appointed car foreman of the Rock Island Lines at Pratt, Kan., succeeding T. J. Butler.

N. E. HOOKER has been appointed assistant foreman of the car department of the Erie at Cleveland, Ohio, succeeding J. E. Fitzgerald.

C. E. STONE has been appointed general car foreman of the Missouri & North Arkansas, with headquarters at Harrison, Ark.

J. A. WILHITE has been appointed car foreman of the Chicago Great Western at South Des Moines, Ia.

SHOP AND ENGINE HOUSE

LEON ATWELL, roundhouse foreman of the Southern Railway at Birmingham, Ala., has been made general foreman at Selma, Ala., succeeding T. S. Krahenbuld.

J. A. BURTON has been appointed night roundhouse foreman of the Chicago Great Western at South Des Moines, Ia., succeeding George Bailey.

G. A. HILLMAN has been appointed erecting shop foreman of the Erie at Galion, Ohio, succeeding H. A. Kinsey.

W. F. MORAN has been appointed roundhouse foreman of the Rock Island Lines at Shawnee, Okla., succeeding A. Hamilton.

F. K. MOSES, foreman at the Garrett (Ind.) shops of the Baltimore & Ohio, has been appointed master mechanic of the Baltimore & Ohio Chicago Terminal shops, at East Chicago, succeeding J. W. Fogg.

S. E. MUELLER has been appointed general foreman of the Rock Island Lines at Rock Island, Ill., succeeding R. J. McQuade.

BERT SMITH has been appointed general foreman of the Rock Island Lines at Eldon, Mo., succeeding W. H. Burleigh.

J. H. STONE has been appointed boilermaker foreman of the Erie at Marion, Ohio.

F. E. WOLFE has been appointed roundhouse foreman of the Chicago Great Western at Hayfield, Minn., succeeding A. T. Helmbrecht.

PURCHASING AND STOREKEEPING

E. J. BURNS has been appointed storekeeper of the Albuquerque division of the Atchison, Topeka & Santa Fe at Winslow, Ariz.

L. C. THOMSON has been appointed general storekeeper of the eastern lines of the Canadian Northern, with headquarters at Toronto, Ont.

ELDRED D. TOYE has been appointed storekeeper of the Ontario Grand division of the Canadian Northern, with headquarters at Toronto, Ont.

OBITUARY

MATTHEW CHARLTON, formerly master mechanic of the Louisville & Nashville Railroad, died of infirmities at his home in Louisville, Ky., on December 25, at the age of 84 years.

COLONEL EDWARD D. MEIER, formerly president of the American Society of Mechanical Engineers, died on December 15 in New York City at the age of 73. He was born in St. Louis, Mo., and graduated from Washington University in 1858. He subsequently spent four years in Germany at the Royal Polytechnic College in Hanover, and later became an apprentice at the Mason Locomotive Works, Taunton, Mass. After serving in the United States army during the civil war he entered the service of the Rogers Locomotive Works at Paterson, N. J. He subsequently was superintendent of machinery of the Kansas Pacific, now a part of the Union Pacific. In 1870 he became chief engineer of the Illinois Patent Coke Company, and two years later was secretary and construction engineer of the Meier Iron Company, and in 1884 organized the Heine Safety Boiler Company, of which he was president at the time of his death. Previous to 1908 he was president of the American Diesel Engine Company and introduced the Diesel motor into this country. He was president of the American Boiler Manufacturers' Association in 1898; president of the American Society of Mechanical Engineers in 1910, and in 1913 represented that society in Munich, at a joint meeting with the German Engineering Society.

SUPPLY TRADE NOTES

The Eddystone plant of the Baldwin Locomotive Works has been put on full time, at least for the next month.

H. R. Sheene has been appointed sales engineer of the Union Switch & Signal Company, with headquarters in room 2039 Railway Exchange building, St. Louis, Mo. Mr. Sheene will report to the resident manager at Chicago.

H. C. Hequembourg, whose election to the vice-presidency of the Standard Chemical Company, Pittsburgh, Pa., has been announced in these columns, was born in St. Louis, Mo. He received his education at Dunkirk, N. Y., and spent the first 21 years of his business life with the Brooks Locomotive Works of that city in the positions, respectively, of bookkeeper, cashier and assistant secretary. When the American Locomotive Company was incorporated in June, 1901, he was made its general purchasing agent, and has remained in that position up to the acceptance of his new appointment. The Standard Chemical Company is a refiner of carnotite ores and produces radium, uranium and vanadium. Mr. Hequembourg as vice-president of the company will be its representative in the east and will have headquarters at 30 Church street, New York. He will also represent the American Vanadium Company in the east.

H. C. Hequembourg

Alexander Harvey, secretary of the Detrick & Harvey Machine Company, Baltimore, Md., died in that city on November 22, of pneumonia. Mr. Harvey was 57 years old, a native of Baltimore, and with Jacob N. Detrick organized the company bearing his name, in 1884. He leaves three sons and a daughter.

T. A. Willson & Co., Inc., Reading, Pa., has been awarded the grand prize at the Second International Exposition of Safety and Sanitation, held at the Grand Central Palace, New York, from December 12 to 19, 1914. The award was given to the company in recognition of the merits of the various Willson eye protectors.

By a recent decision of the directors of the Pullman Company, the work of building one steel sleeping car a day will continue throughout the winter months. Because of the small demand for cars during the past few months a discontinuance of this policy had been considered, but the recent decision will afford work to the men during the winter.

On December 10, 1914, Judge Hazel, of the Western District of New York, handed down a decision in the suit of the Safety Car Heating & Lighting Company vs. the United States Light & Heating Company, holding patent No. 747,686, issued to J. L. Creveling, and owned by the former company, valid and infringed by the apparatus of the latter company. There were eight claims in the suit and all were sustained. The patent covers regulating devices for regulating the output of a variable speed generator and means for controlling the regulating devices to determine the output.

Arthur E. Jackman has been appointed manager of the machinery department of the Walter A. Zelnicker Supply Company, St. Louis, Mo., succeeding J. J. Hilpirt, who has resigned to become storekeeper of Cia. Mexicana De Petroleo, "El Aguila" S. A. at Tampico, Mex. Mr. Jackman was at one time general manager of the Sea View Railroad and the Narragansett Pier Electric Light & Power Company. He was also for years in the railway and lighting department of the Westinghouse Electric & Manufacturing Company, and left the position of superintendent of the East St. Louis, Columbia & Waterloo Railway to assume his present duties.

The fire that destroyed part of the Edison Phonograph Works, at Orange, N. J., on December 9, did not in any way affect the Edison Storage Battery Company. One end of the large concrete buildings of the battery works is across the street from Mr. Edison's private laboratory, which was saved, and this as well as the rest of the plant escaped unscorched. The fire started about 5:20 in the afternoon and was under control by 10 o'clock. The telephone exchange was in one of the burned buildings, but through the prompt action of the New York Telephone Company a temporary switchboard was working in the battery office before business hours the next morning and the Public Service Electric Company had emergency lines furnishing power nearly as soon. The business of the Edison Storage Battery Company, therefore, suffered no interruption whatever.

Eli Stillson Hart, chairman of the board of the Rodger Ballast Car Company, Chicago, and one of Chicago's oldest residents, died at his home, 2922 Prairie avenue, on November 23, after an illness of several weeks. Mr. Hart was born in Rochester, N. Y., in 1832. In 1855 he was graduated from Hamilton College in the law school. He began the practice of law in Clinton, Ia., and came to Chicago in 1856, where he continued his law practice as a member of a leading firm of that period. In 1874, owing to ill health, Mr. Hart gave up his legal work to engage in business. He was one of the founders of the Rodger Ballast Car Company, the success of which was due to his ability, and until his death he was chairman of board of directors. Mr. Hart's integrity of character, sound judgment and kindly humor made him many friends. He is survived by three children: Miss Gertrude W. Hart, H. Stillson Hart and Mrs. Evan A. Evans.

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Eli S. Hart

William F. Bauer, assistant manager of the railway department of the Edison Storage Battery Company, Orange, N. J., has been appointed manager of the Chicago office of that company, succeeding Charles B. Frayer, who retired on November 30 to devote himself to private interests. Mr. Bauer has been engaged in storage battery work for many years. In 1889 he was the electrician in charge of the original train lighting equipment of the Pennsylvania's Chicago Limited, a lighting system designed by his father, then chief electrician of the Pullman Company. He later had experience with the Electric Accumulator Company, the Westinghouse Electric & Manufacturing Company, the Pullman Company and the Wagner Palace Car Company. In 1901 he entered the employ of the Consolidated Railway Electric Lighting & Equip-

ment Company and two years later was appointed chief electrician of the Missouri Pacific, in charge of car lighting. In 1906 Mr. Bauer became sales engineer of the Electric Storage Battery Company. He has been with the Edison Storage Battery Company for about a year and is president of the Railway Electrical Supply Manufacturers' Association.

Charles Arthur Moore, president of Manning, Maxwell & Moore, New York, died of heart disease on board the steamer Rotterdam, on which he was en route for Naples. Aside from his position as president of Manning, Maxwell & Moore, he was president of the Shaw Electric Crane Company, Consolidated Safety Valve Company, Ashcroft Manufacturing Company, Hancock Inspirator Company, Hayden & Derby Manufacturing Company, United Injector Company, and was a director of the Continental Insurance Company, the Liberty National Bank, the American Bank Note Company and the National Machinery Company. Mr. Moore was born in West Sparta, N. Y., in 1845, and was educated in the public and private schools of Rochester, N. Y., and Lynn, Mass. He enlisted in the navy at the outbreak of the civil war and served throughout the war. He then became a salesman in New England, and in 1880 joined the firm of H. S. Manning & Co., of New York, forming the firm of Manning, Maxwell & Moore, manufacturing railroad supplies. In 1905 the business was incorporated and Mr. Moore became president and a controlling owner. Mr. Moore was a member of the Chamber of Commerce, National Civic Federation, New York Board of Trade and Transportation, American Society of Mechanical Engineers, Empire State Society of Sons of Revolution, Ohio Society, St. Andrew's Society, Pilgrims of the United States and Society of Genesee. He was a member of the Automobile Club of America, Army and Navy, Republic, Union League, Lotus, Engineers, New York Railroad, Machinery, Lawyers and Transportation clubs, and the founder and for ten years president of the Montauk Club.

Charles A. Moore

NEW SHOPS

Missouri Pacific.—This company will build a 10-stall 95-ft. frame engine house at Horace, Kan., to replace the one recently destroyed by fire. The work will be done by company forces.

Oregon-Washington Railroad & Navigation Company.—Work has been begun on the division terminal buildings of this company at Spokane, Wash., which consist of an 11-stall roundhouse, a machine shop, 80 ft. by 120 ft., a power house, 40 ft. by 50 ft., a coaling plant, cinder pit and coach cleaning facilities. The power house will be of concrete construction, and the other buildings will have brick walls and mill constructed frames. Work is being done by company forces and the approximate cost will be $150,000.

Southern Railway.—This company has given a contract to the Murphy Construction Company, East St. Louis, Ill., for the construction of an 18-stall roundhouse, machine shop building, store, oil and office building, at Denverside yard, East St. Louis.

CATALOGS

Ventilated Commutating Pole Railway Motors.—The General Electric Company, Schenectady, N. Y., has issued bulletins No. 44,403 and 44,405, describing the company's commutating pole railway motors for 600 volt and 600/1,200 volt service. Both motors are described in considerable detail.

Dust Guards.—The National dust guard is the subject of a 12-page booklet issued by the National Railway Equipment Company, Toledo, Ohio. This dust guard is made entirely of steel and fiber and aside from the adjusting clamps consists of but three pieces. It is being tried out on nearly 100 different railways.

Portable Electric Drills.—Circular E-2, just issued by the Independent Pneumatic Tool Company, Chicago, Ill., deals with the Thor portable electric drills which are manufactured by this company. It contains four pages and includes illustrations and sizes of these tools, as well as tables giving the various characteristics of each.

Torches for Steel Car Repairs.—The Mahr Manufacturing Company, Minneapolis, Minn., has issued an illustrated booklet devoted to the Mahr steel car repairing torches. These torches will burn either kerosene or crude oil and are fitted with interchangeable nozzles. They are also made in sizes suitable for boiler shop and other work.

Portable Electric Tools.—A catalog recently issued by the Neil & Smith Electric Tool Company, Cincinnati, Ohio, is devoted to this company's Ideal line of portable electrically-driven tools. The booklet contains 56 pages, thoroughly illustrated and describes a considerable number of types of electric grinders and buffers, drills, screw drivers, etc. Several pages are also devoted to electrically-driven saws and a table of grinding wheel speeds is included.

Ratchet Brake Lever.—A 15-page booklet issued by the Pittsburgh Railway Appliance Company, Farmers Bank building, Pittsburgh, Pa., deals with the Acme ratchet brake lever and contains a number of illustrations showing this type of lever in its different forms and applied to different classes of freight and passenger cars. Illustrations and descriptive matter are also included dealing with the universal journal box lid manufactured by the same company.

Paint Tests.—An eight page leaflet has been published by the Joseph Dixon Crucible Company, Jersey City, N. J., as a supplement to the October, 1914, issue of Graphite, which is entitled The Atlantic City Steel-Fence Paint Tests. As the title indicates this pamphlet deals with the final report of inspection of the steel paint test fence which was presented at the meeting of the American Society for Testing Materials, held in Atlantic City in July of this year. A brief history of the test is given, followed by a discussion of the results as reported by the inspection committee.

Steel Pipe.—History, Characteristics and Advantages of National Pipe is the title of National bulletin No. 11-C issued by the National Tube Company, Pittsburgh, Pa. The second edition, enlarged, was issued in November, 1914. This bulletin is a 48 page booklet and goes into the subject of steel pipe very fully. It is divided into chapters and is thoroughly illustrated. The National Tube Company has also issued recently information regarding the increase in the amount of steel pipe manufactured from 1888 to 1913. In 1888 there were approximately 500 tons of wrought iron pipe manufactured, while the amount of steel pipe manufactured was negligible. In 1905 the amount of wrought iron pipe manufactured had decreased to 452,797 tons while the steel pipe manufactured had increased to 983,198 tons. In 1913 the wrought iron pipe had decreased to 312,746 tons and the steel had increased to 2,189,218 tons.